APRIL 28, 1958 PRICE 50 CENTS

Design edition

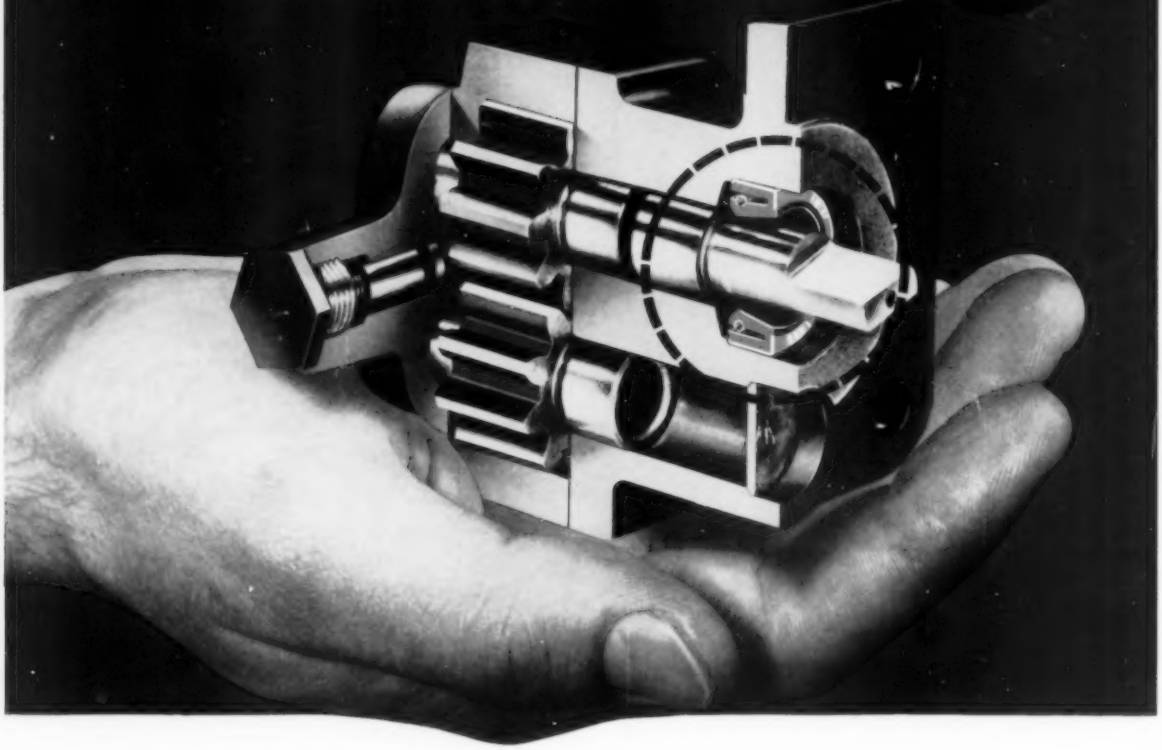
# Product Engineering

McGRAW-HILL MAGAZINE OF DESIGN
RESEARCH AND DEVELOPMENT

*Rocket sled tests Titan components at China Lake—see page 5*

SANDWICH FACINGS • STEEL CASTINGS • MAGNETIC COUPLINGS

# Champion performance in a fist-sized pump...sealed by C/R



## THE PROBLEM:

### To seal a rotary pump handling a wide range of fluid viscosities, pressures and temperatures

These pumps are performing dependably in hundreds of different hydraulic applications. They handle any fluid with lubricating qualities . . . deliver up to 180 gph, and maintain high volumetric efficiency even with low viscosity fluids. This particular pump also carries Underwriters' Laboratories approval for use in oil burners. For dependable sealing, C/R's Type HMS Oil Seal was chosen. It performs effectively from 28" Hg to 5 psi, and from 50 to 8000 rpm. This is only one of the thousands of ways in which C/R Oil Seals and engineering are solving difficult sealing problems throughout industry. C/R engineers can help you, too—especially where critical conditions exist. A letter or telephone call will get them started for you. Write for your copy of the catalog, "C/R OIL SEALS."

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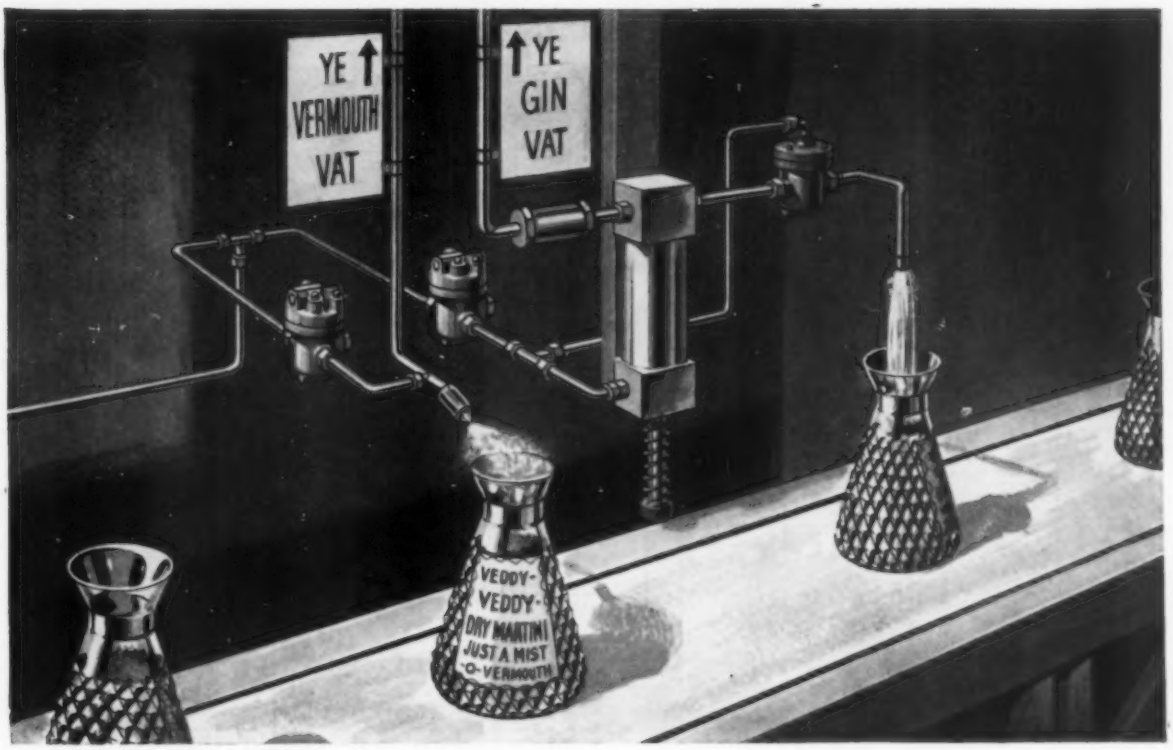



# What? Air Automates the Extra, Extra-Dry Martini!

**The ready mixed Martini may never come to this but . . .**

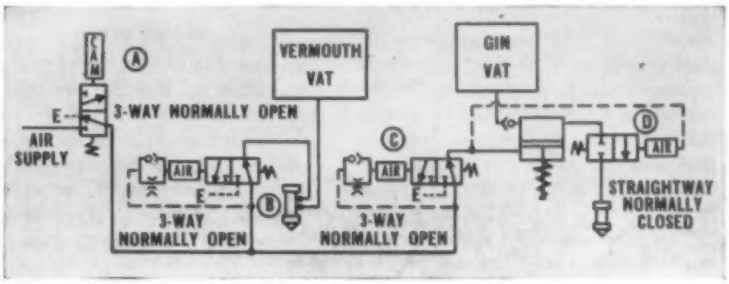
"Don't bruise the Vermouth!" Maybe you subscribe to the idea of only a fog of Vermouth or maybe you like yours four-to-one. But, if it came to bottling this vogue-ish mixture, the circuit here could certainly do it. Meanwhile it gives us a fanciful way to show you how you can easily create an all air circuit that does a continuous sequence of timed operations by using valves that can be both operated and sequenced by air. Every time the conveyor stops, it triggers the circuit.

**Triggering one operation with another and timing the operating periods—all with air—may save the day for you.**

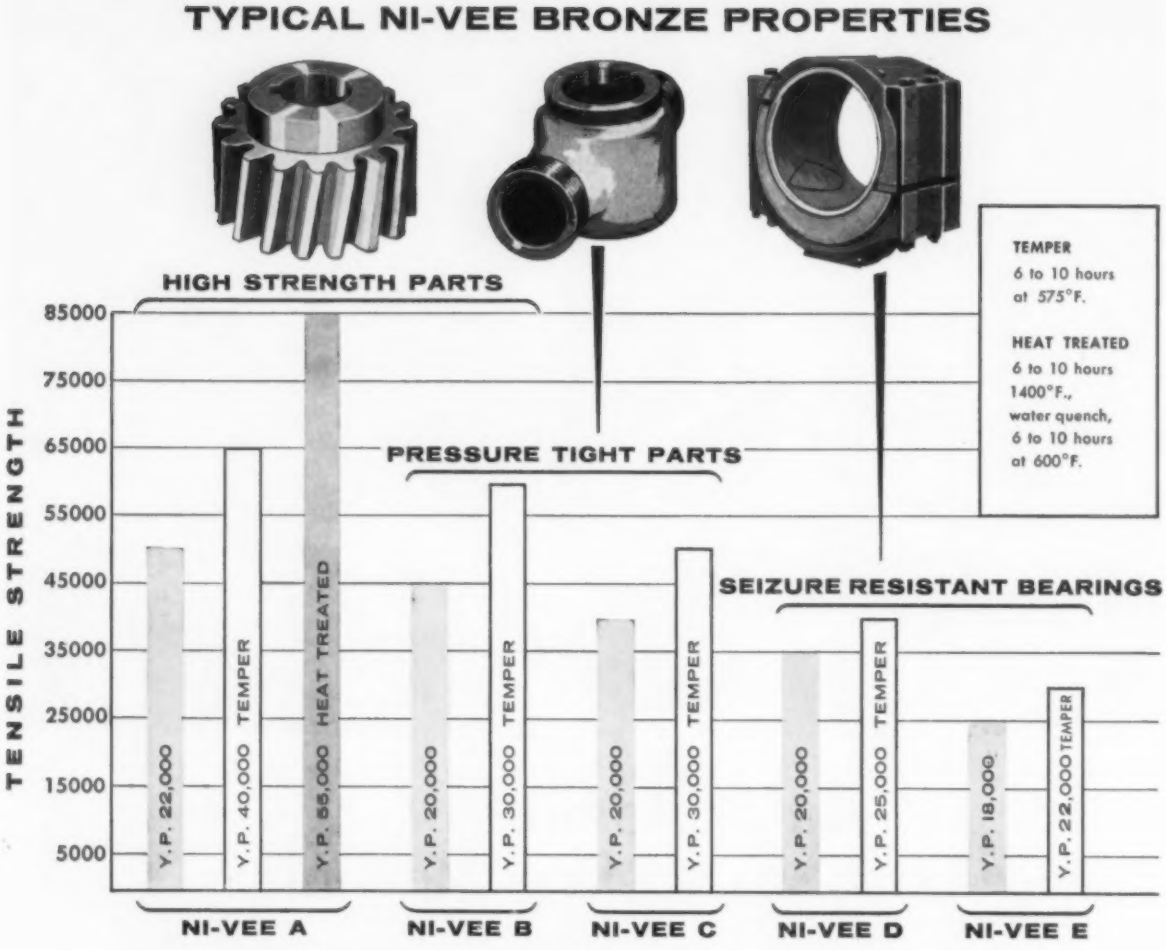
The same air involved in the main operation can also pilot these valves. What's more these valves can be preset to wait out a time delay before operating, or operate for a self-measured time. Using them you can create unlimited all-air automation systems which could just turn the trick where you wish to avoid electricity, or want to stick with just one power medium.

SEQUENCE OF OPERATION

1. Conveyor indexes, opening cam valve (A). This introduces air to valves (B) and (C) which begin timing out. Vermouth is atomized by Vermouth nozzle, cylinder expels a measured amount of gin through master valve (D) which has been opened by air from the outlet of valve (C).
2. Valves (B) and (C) time out and close, stopping liquid flow.
3. Conveyor indexes again.




**Ross** OPERATING VALVE CO. 114 East Golden Gate • Detroit 3, Michigan




# 5 high-performance bronzes

*These versatile Ni-Vee alloys provide a range of properties that satisfies the requirements of most copper-base castings*

The chart shows the range of tensile properties of the five Ni-Vee* bronzes and indicates the types of castings made with these alloys.

As you can see, you can satisfy the majority of your specifications for quality copper-base castings from among these five versatile Ni-Vee materials. Their "As Cast" mechanical properties – especially yield strength – surpass those of comparable G and leaded bronzes and red brasses.

The chart also shows what simple heat treatment does to step up their properties. Bear in mind that values taken from the chart are typical. In practice, higher values can be obtained.

### Ni-Vee extras

You can expect superior performance from all five Ni-Vee bronzes. For example. Ni-Vee B, C, D, and E (the leaded group) can be used for castings of all three classifications shown. Ni-Vee A provides extreme strength. Ni-Vee E gives you extreme resistance against galling or seizure. The low zinc group (Ni-Vee A, B, D and E) show little tendency to dezincify, insure top-notch resistance to stress corrosion. All five, of course, have the excellent general corrosion resistance of copper reinforced by a 5% nickel 5% tin content.

### Helpful booklet gives complete information on Ni-Vee bronzes

"Engineering Properties and Applications of Ni-Vee Bronzes" covers tables of composition, charts on deformation, friction, fatigue, elevated temperature service, electrical resistivity, wear and other engineering data. Write for your copy today.

*Registered trademark

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67 Wall Street INCO New York 5, N. Y.

# NI-VEE BRONZES
## NICKEL ALLOYS PERFORM BETTER LONGER

# Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN, RESEARCH AND DEVELOPMENT

APRIL 28, 1958 Vol. 29, No. 17

**Report on the Design Show** 41 . . . By the editors of PRODUCT ENGINEERING
Eight extra pages bring you this special feature—reporting the panel session and evaluating exhibits at the show just closed.

**Sandwich Panel Facing Materials** * 80 . . . R. K. Humke, Minnesota Mining & Mfg. Co.
Following up his article on core materials, the author here goes into proper selection of skins for the bonded composites. The next in his 3-part series will be a guide to sandwich adhesives.

**A Casting Alloy for High Strength** 84 . . . E. G. Upsahl and W. H. Sparing, American Steel Foundries
This special steel offers advantages of economy and fewer fabricating headaches. Here are its properties, plus design tips.

**Design Features in New Products** 86 . . . Three looks at air springs—Dutch, German, American; milling machine takes double scalp; castings cut mower costs; armatures assembled automatically.

A HOW-TO

**Low-cost Sound Lab** 91 . . . Anechoic chamber built by the Elliot Co. shows noise-testing can be done cheaply—with lots of asbestos around steel framework.

**Design Laws for Fan Selection** * 92 . . . A staff report
Choosing the right fan is often more than just a matter of type. Here are charts, tables, sample problem—and three fan laws that help decide when a smaller unit could do the same job.

**Rubber Cushions—Quiet Bearings** 96 . . . R. E. Downs, The Fafnir Bearing Co.
In many applications the hum of a mounted bearing can be a severe annoyance. These tests show advantages of enclosing the bearing with a rubber sleeve.

**Hermetic Magnetic Couplings** 98 . . . D. A. Guerdan, Westinghouse Electric Corp.
Magnetism will transmit torque right through a steel wall, but success depends on proper materials. Article gives results for a 50-rpm application and predicts design for 1800 rpm.

DESIGN FILE

**Metal Inserts for Plastic Moldings** 104 . . . Federico Strasser
A survey of the four broad types of helpful inserts.

**Starting Current—NEMA Limits** 107 . . . C. C. Libby, Fairbanks, Morse & Co.
Here's how to figure starting current from NEMA code letters.

DEPARTMENTS

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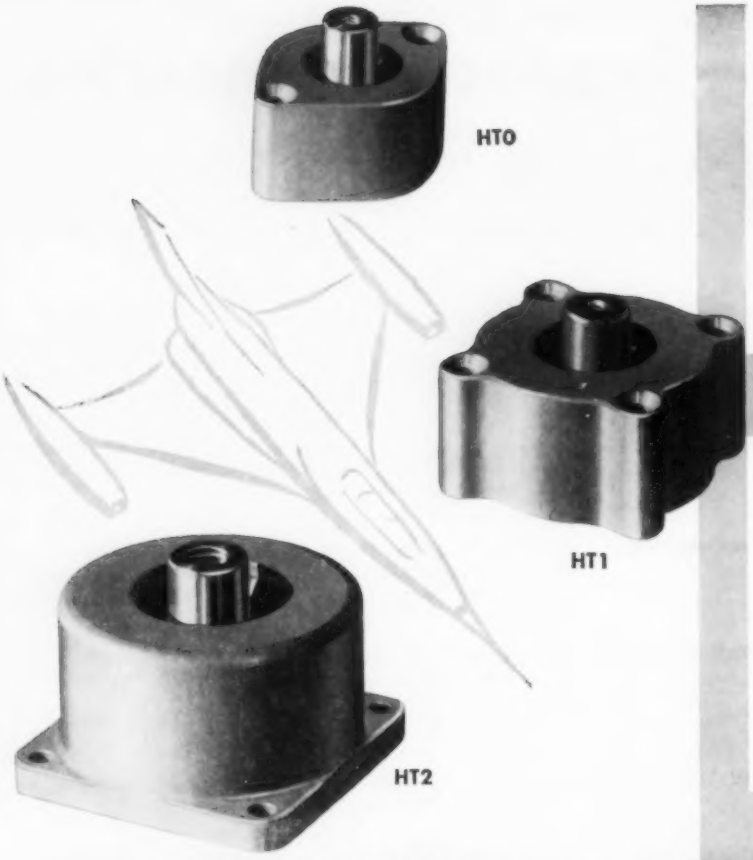
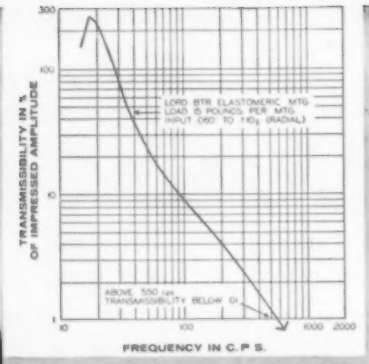
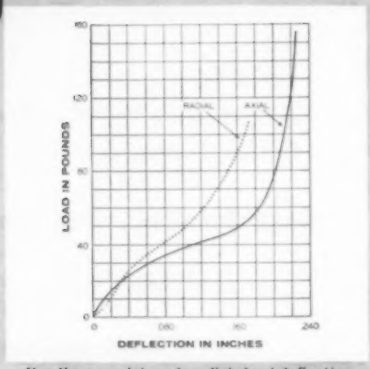




TRANSMISSIBILITY IN % OF IMPRESSED AMPLITUDE
LORD BTR ELASTOMERIC MTG.
LOAD IS POUNDS PER MTG.
INPUT DEG. TO 1 KC (RADIAL)
ABOVE 550 cps
TRANSMISSIBILITY BELOW 1%
FREQUENCY IN C.P.S.

Transmissibility curve for new Lord BTR Mountings exhibits no discontinuities. Above 550 c.p.s., transmissibility is below 1%.




Non-linear axial and radial load-deflection curves show smoothly increasing shock absorption characteristics of BTR Mountings.

# new LORD BTR mountings for airborne electronic equipment

LORD announces a new series of vibration control mountings for the protection of airborne electronic equipment. They incorporate LORD's new Broad Temperature Range elastomer—"BTR"—which combines performance-proved elastomeric advantages with extreme environmental resistance.

BTR Mountings provide excellent all-attitude vibration isolation of frequencies to 2000 c.p.s. under steady-state accelerations and transient shock conditions . . . with no standing waves, distributed system responses or "bottoming". Broad temperature operation is possible since transmissibility and resonant frequency remain virtually constant from −65° to 300°F.

The BTR elastomer combines three functions: load carrying, damping and snubbing. It resists oil and ozone, has high tensile strength, high tear resistance and good flex life.

The new mountings are designed in three basic sizes—HT0, HT1 and HT2—for loads from 3 to 80 pounds per mounting. Specification MIL-C-172B mounting hole configurations provide maximum interchangeability in standard military equipment.

For further details on the new BTR Mountings, consult your nearest LORD field engineer, or contact the Home Office, Erie, Pa.

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# Interesting to Note . . .

## Sled Testing

In their conquest of India, the British forces had to fight against a strange new weapon. It was a rocket made of bamboo like the earlier Chinese ones, but armed with an incendiary charge. Called the Bangalore torpedo, the weapon was equipped with a long tail-stick to stabilize flight and had a range of about 1000 yards. Needless to say, rocketry has come a long way since. However, even in the 18th century, any new rocket or missile had to be tested before it was adopted for combat.

Our cover shows a 1958 testing method for the inertial navigation system being developed by Arma Div., American Bosch Arma Corp., for the Air Force Titan (ICBM). This ground testing is conducted on a rocket sled along a 4.1-mile stretch of track located at the Naval Ordnance Test Station, China Lake, Calif. The sled, built by AERojet-General Corp., consists of two units: nose section designed to carry the payload, and rocket-engine propulsion section.

With this sled, such components as gyros and accelerometers undergo acceleration similar to that in actual launching and flight of a ballistic missile. The sled's terrific momentum after engine shutdown is braked by a water scoop underneath. Total elapsed time of run—about 40 seconds.

## The Kansas City Chemist

In the mid-1920s a chemist in Kansas City, Mo., named Dr. J. C. Patrick, was trying to find a better and cheaper antifreeze. In a beaker he placed some ethylene dichloride, then added sodium polysulfide. Instead of getting antifreeze he had a gummy mass of "gunk." The more he stirred, the gummier it became. It looked like natural rubber, wouldn't deteriorate in air or gasoline and in many respects had better properties than rubber then on the market. Dr. Patrick put his goo in a glass and took it to a client, Bevis Longstreth. Longstreth was very interested and in 1929 founded the Thiokol Chemical Corp. to produce America's first synthetic rubber.

The demand for synthetic rubber wasn't great; America was able to import all the natural rubber it needed from Asia. In 1929, Goodyear's chemist, R. P. Dinsmore, had also patented a process to make a synthetic rubber but it was too expensive—the plan was shelved. But when Hitler took over Germany in 1933, officials at Goodyear decided they had best perfect a synthetic rubber, just in case. In 1937, they produced their first synthetic tire. When Pearl

*(Continued on page 7)*

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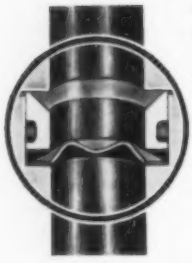

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. . . same long wearing leak-proof qualities — metal to metal *'Shear-Seal'* design is not sensitive to dirt, compensates for wear.

. . . same installation savings — because no oilers or filters are needed.

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*Write for bulletin 5000 which includes design specs.*

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| Machine tool chucking & clamping | Maintaining safe holding pressure (leakproof) | Saving auxiliary equipment such as pilot operated check valves |
| Automatic door openers | Quick action (high flow capacity) | No spools or poppets obstructing full, round flow passages |
| Solenoid controlled hydraulic system on machine you build | Better performance<br>Lower manufacturing costs<br>Reduce service problems | Shear-Seal valves have full flow, are leakproof, not sensitive to dirt<br>Low priced, less auxiliary equipment and labor cost.<br>Valves don't stick, saving coil burn-out; stay leakproof indefinitely, seals are wear compensating |

Write for Catalog 58-59

CONTROL VALVE DIVISION

**Barksdale valves**

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

Harbor was attacked, our Malayan rubber was shut off and synthetic rubber became front-page news.

Rubber today, natural or synthetic, still plays an important part in our daily lives. Whether in the form of a cushion for bearings (see page 96) or a bladder large enough to raise the sunken Andrea Doria, we'll use more and more elastomers through the years.

### No Time to Eat

Ask the man on the street who Robert Teller is and few could correctly identify him—far more would know the world-renowned gambler, Nick the Greek. Why a gambler receives more recognition than a scientist is part of the social problem that will have to be appreciated before America can turn more young people toward scientific fields. Anyway, gamblers as well as men of science have been around a long, long time. But to find one man who was both a professional gambler and a scientist is indeed a rarity.

John Montagu was such a man. He lived in England during the 18th century and kept himself mainly behind the card table. At his London mansion a card session was always in progress—with time off only at noon and in the evening for his guests to eat. Finally he thought of a way to feed his friends without stopping the card game. By placing pieces of meat, watercress or cheese between two slices of bread, the players could eat with one hand while holding cards in the other. This method of eating was not exactly original. Roman legionnaires and highwaymen had developed similar methods of eating, but credit for the quick repast has been given to gambler John Montagu, fourth Earl of Sandwich.

Even in design, "sandwich" construction has found a place. The article on page 80 gives important design information on facings—the "bread" that encloses a structural sandwich.

### The Great Stone Faces

**"Too little of civilization lasts into tomorrow and tomorrow is strangely the enemy of today"— Gutzon Borglum.**

In the Black Hills of South Dakota stands impressive Mount Rushmore National Memorial—monument to Washington, Jefferson, Lincoln and Teddy Roosevelt. Impressive as the memorial is today, more impressive was the actual feat of carving the granite mountain. In 1923, Dr. Doane Robinson, State Historian of South Dakota, presented the idea to State and Federal officials. His plan was accepted and American-born sculptor Gutzon Borglum was called in to handle the project.

In the summer of 1927, Borglum began by preparing plaster-of-Paris models. Then, with between 25 and 40 men, he blasted and air-drilled the mountain rock to within 6 inches of final carving depth. One problem was getting men safely up and down the mountain wall. Borglum devised a sling with a cable attached to it. Each man was assigned a number and would have himself raised or lowered by yelling his number to a call boy on top of the cliff. By telephone, the boy would relay instructions

to the winch houses where other men would manually control the cables.

Although most of the rock was blasted away, the final 10% had to be carefully drilled by air. (For a current use of air for power—automobile springs—see page 86). In 1941, Borglum died and work on the monument stopped. Had it been finished it would have included a carved tablet shaped in the form of the area that made up the Louisiana Purchase, and continuing a 500-word history written by former President Coolidge. The busts were to have been carved to the waist. Lincoln's eyes measure 6 ft between the lids.

### Successful Failures

No statistics are available showing how often a good idea was shelved for lack of capital or courage. We do know, however, that some experiments have been considered failures, then forgotten, when actually an inventor had reached his objective. Henri Moissan, for example, tried to produce synthetic diamonds by placing dissolved carbon in molten iron, then suddenly cooling the mass. Within the hard iron crust, he found microscopic colorless crystals which he discarded. They couldn't be diamonds, they were too small. In 1906, 13 years later, Sir William Crookes reported a similar way to produce artificial diamonds, yet it was only last year that the General Electric Co. announced first commercial production of man-made diamond (*PE*—Nov. 11, '57, p. 116)—using heat and pressure.

Another bypassed discovery came out of the laboratory of an Englishman, Harry Brearley (*PE*—Dec. '56, p. 7). In 1912 he announced a material for a new gun-barrel lining. Tests showed it would resist the corrosive effects of black powder, and several gun manufacturers became interested. Unfortunately, the development of smokeless powder sidetracked need for Brearley's invention and left him holding what today is called stainless steel.

It's ironical that stainless castings in the form of aircraft-engine shroud rings are today constantly winging over Harry Brearley's laboratory. Steel castings for another purpose—high-strength structural applications, are described on page 84. —Benedict A. Leerburger, Jr.

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**CHROME PLATED CYLINDER BORES AND PISTON RODS** . . . Standard at No Extra Cost!

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**NEW "SELF-ALIGNING" MASTER CUSHION FOR HYDRAULIC USE** . . . Standard at No Extra Cost!

**NO TIE-RODS TO STRETCH** . . . Standard at No Extra Cost!

**STREAMLINED DESIGN** . . . Oil Pressure to 750 P.S.I.—air to 200 P.S.I. Standard at No Extra Cost!

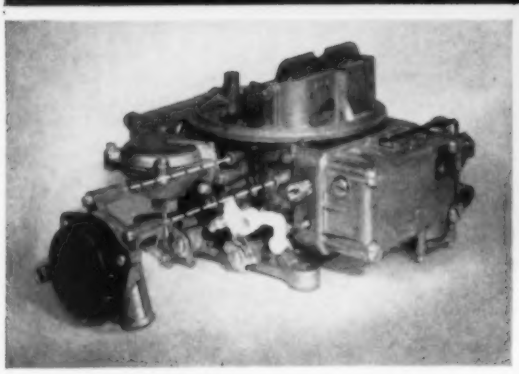
**FORGED SOLID STEEL HEADS** . . . Standard at No Extra Cost!

T-J TOMKINS-JOHNSON
RIVETORS, AIR AND HYDRAULIC CYLINDERS, CUTTERS, CLINCHORS

**SEE US AT BOOTH 1423**
**A. S. T. E. SHOW**

# Here's the new nylon idling cam produced by Chicago Molded for Holley Carburetor

*Nylon replaces metal in automotive cam . . . eliminates 3 operations, cuts costs more than 50%*



Many models of Ford Motor's Lincoln, Mercury and Edsel are equipped with latest-type Holley automatic carburetors. In inset photo, choke housing has been pulled away to show the molded nylon fast-idle cam as assembled.

This nylon fast-idle cam made by Chicago Molded for Holley offers less friction, and resists wear better than cams of low carbon steel. Furthermore, injection-molding it of nylon eliminates three operations – hardening, stamping, assembly – at production savings of more than fifty percent.

**Holley is able to change the cam design without obsoleting the entire mold.** That's because Chicago Molded designed a unique multiple-cavity mold made with removable sections. This permits easy changes in the number and sizes of the ratchets with very little expense, when the basic part is redesigned.

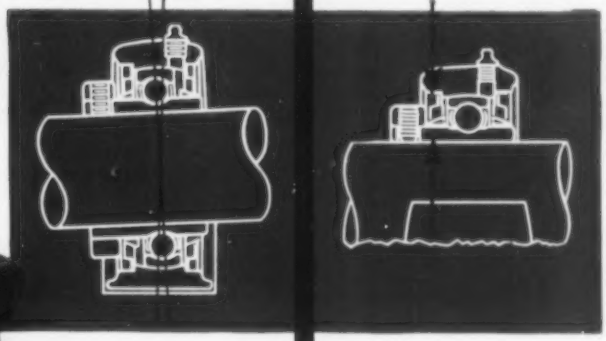
Designing and making molds that cut costs – and allow for low-cost changes – is a specialty of Chicago Molded's engineering staff. Why not find out if they can cut your costs? Ask, too, for a free subscription to *Plastics Progress* – the data-packed magazine on new developments in plastics. Write:

**CHICAGO MOLDED**
**PRODUCTS CORPORATION**
**1032 North Kolmar Avenue, Chicago 51, Illinois**

# Self-aligning SEAL AND ALL

**SELF-ALIGNMENT** is assured because the lubricated, spherical outer ring is free to align in any direction. Full load capacity is always maintained regardless of shaft deflection or misalignment.

**POSITIVE PROTECTION** of the rolling elements from moisture, dust and dirt is provided by self-aligning seals extending from housing to inner ring. Large grease reservoir prolongs lubrication intervals.



Series 200 and 300 ball bearings

**That's why grease stays in, dirt out of these LINK-BELT ball bearings**

To compensate for supports and shafts that misalign in service . . . for unavoidable inaccuracies in mounting—Link-Belt offers self-alignment in ball bearings. And to protect that vital feature against dust and dirt, Link-Belt provides effective seals that *align along with rolling elements.*

Self-alignment is standard throughout industry's most complete line of ball and roller bearings—pillow blocks and flange, flange cartridge, cartridge and take-up units. Ask any one of 40 Link-Belt offices for Book 2550.

14,330-A

**LINK BELT**

**self-aligning ball and roller bearings**

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7, Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World.

# Excellent Machinability of Magnesium Cuts Production Costs

## Easy machining means faster machining, less wear on tools, lower costs

Designers working in today's highly competitive markets are finding it more important than ever to consider production costs when they're selecting materials. Magnesium alloys offer much needed economies in this respect. In fact, few other structural metals are so versatile and easy to work with in production operations.

Take machining, for example.

The excellent characteristics of magnesium alloys permit machining operations at extremely high speeds—usually at the maximum obtainable speeds of modern machine tools. Heavier depths of cut and higher rates of feed than are used on other metals are possible when machining magnesium. The life of high speed steel cutting tools when machining wrought magnesium is equal to the life of carbide tipped tools when machining other metals!

**MAXIMUM OPERATING SPEEDS** of automatic machine tools can be utilized in machining magnesium.

Magnesium lightness, which allows easy, efficient handling of large parts, plus excellent machining characteristics add up to substantial savings in production costs.

**TURNING AND BORING.** A wide range of cutting speeds, feeds and depths of cut are possible in turning and boring magnesium. Rough cuts vary from 300 fpm, 0.100 ipr and 0.800" in depth to 5,000 fpm, 0.010 ipr and 0.150" deep. Finish cuts may vary from 300 fpm, 0.025 ipr and 0.100 inches to 5,000 fpm, 0.003 ipr and 0.050 inches.

**MILLING.** The outstanding machining characteristics of magnesium can be used to full advantage in milling operations. Heavy feeds and milling speeds up to 9,000 fpm remove the metal rapidly with excellent surface finish.

**DRILLING.** The maximum speeds of standard drilling equipment can be utilized to the fullest extent. Speeds used in commercial shops on other metals are 75 to 400 fpm, but speeds up to 2,000 fpm can be used with magnesium.

**SAWING.** Magnesium is readily cut with band, circular, hand or power hack saws. Because of the low cutting pressure, larger cuts can be taken per tooth than are possible with other metals.

**AUTOMATIC SCREW MACHINE WORK.** Extruded magnesium screw machine stock is available in all common sizes and shapes. It usually costs less on a cost-per-part basis than any other metal except steel. The use of magnesium permits feeds as much as 50% to 75% higher than those used with brass. Magnesium causes less tool wear, which lowers tool cost and reduces machine down time.

It is often possible to reduce part costs because of the low power consumption, the high feeds and speeds and the excellent surface finishes that result from using magnesium. The light weight of the metal exerts less wear on spindles, belts and motors, especially where quick changes of speed are involved.

**TAPPING AND THREADING.** Threads which are not held to close tolerances may be tapped in magnesium alloys with standard taps. Threads may be chased in magnesium alloys at the rate of 1,000 feet per minute.

**GRINDING AND POLISHING.** Finish grinding of magnesium is often unnecessary inasmuch as finishing cuts give extremely accurate and smooth surfaces. Rough grinding, however, is widely used in foundry clean-up and for removing flash from die castings and forgings.

Polished surfaces of any desired quality are easy to obtain on magnesium. Surface irregularities are removed readily by polishing operations. High lustre surfaces on articles to be plated or used for decorative purposes can be produced by buffing.

In all other machining operations, such as shaping and planing, reaming, counterboring and filing, the advantages of magnesium also pay off in terms of faster production, lower costs and less tool wear. Thousands of metalworking shops are efficiently and safely working with magnesium every day. Why not consider magnesium for the products or parts you're working with now?

| METAL | RELATIVE POWER REQUIREMENT |
|---|---|
| magnesium | 1.0 |
| cast aluminum | 1.8 |
| brass | 2.3 |
| cast iron | 3.5 |
| rolled aluminum | 5.0 |
| mild steel | 6.3 |

**RELATIVE POWER** required to machine different metals under the same conditions is shown by this comparison (1.0 = lowest power required).

**MACHINING MAGNESIUM**, a 60-page handbook, discusses all methods of machining mentioned above. Also includes tables on speed, feed and depths of cut, basic information on magnesium properties, tool design and safe procedures. For your copy, contact the nearest Dow office or write THE DOW CHEMICAL COMPANY, Midland, Michigan, Department MA 1453V.

YOU CAN DEPEND ON DOW

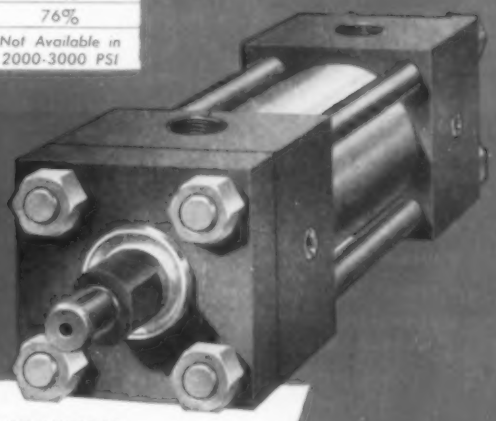
# Save 27% or more in cost...

## NEW Miller "JOB RATED" HYDRAULIC CYLINDER LINE

**JOB RATED, MODEL " J "**

| BORE | SEVERE OPERATING CONDITIONS | MODERATE OPERATING CONDITIONS | YOU SAVE THIS % IN PRICE OVER STANDARD 2000-3000 PSI CYLINDERS |
|---|---|---|---|
| 1½" | 1500 PSI | 2500 PSI | 27% |
| 2 | 1500 | 2500 | 27% |
| 2½ | 1000 | 1500 | 28% |
| 3¼ | 1500 | 2500 | 32% |
| 4 | 1000 | 1500 | 35% |
| 5 | 800 | 1200 | 37% |
| 6 | 800 | 1200 | 43% |
| 8 | 500 | 800 | 50% |
| 10 | 500 | 800 | 71% |
| 12 | 500 | 800 | 76% |
| 14 | 500 | 800 | *Not Available in 2000-3000 PSI* |

***with IDENTICAL seals, design, and safety factors as the famous Miller "Power-Packed" Model "H" Line for 3000-5000 psi service.***



## SEAL FAILURE MEANS CYLINDER FAILURE!

1. *No seal made of synthetic rubber is compatible with even 50% of available, commercial, petroleum base hydraulic fluids.*

**MILLER Uses All Teflon* Seals to Eliminate External Oil Leakage because** Teflon is impervious to all known hydraulic fluids, even fire-resistant types.

**TEFLON SHEF SEAL At Tubing Ends**

No blind assembly. Is
**Shear-proof**
**Heat-proof**
**Extrusion-proof**
**Fluid-proof**

**TEFLON Seals On Piston Rod And Bushing**

Teflon rod flange seal requires no adjustment. Teflon bushing seal is shearproof. Teflon wiper keeps dirt out.

**TEFLON Seals On Ball Check And Adjusting Screw**

Non-protruding, self-locking, cushion adjusting screw interchangeable with ball check for easy access.

**MILLER Uses Resin-Impregnated Leather Piston Cup Seals because** they are compatible with petroleum base fluids and some fire-resistant types. Teflon cups available at small extra cost.

2. *Nicked or scored piston rods cause seal failure*

**MILLER Uses Case-Hardened Chrome-Plated Piston Rods** because they prevent nicks, scoring and rust.

*Visit Our Booth #1625 A. S. T. E. Show, Philadelphia, May 1-8*

**NOW!** ..... You can save MORE with quality Miller "Job-Rated" Cylinders than with cut-price, lesser quality hydraulic cylinders. And the "Job-Rated" Cylinders are also available under the same immediate shipment program as the Power-Packed Line (2 hours if necessary—3 days normal).

*Du Pont trademark for tetrafluoroethylene resin which withstands temperatures from −100° F. to +500° F. and all hydraulic fluids.

S SHEAR PROOF
H HEAT PROOF
E EXTRUSION PROOF
F FLUID PROOF
SEAL
Teflon Pressure Energized
Hydraulic Cylinder Tubing End Seal
PAT. APPLIED FOR

**OTHER MILLER QUALITY FEATURES**

- Rust-Resistant Surfaces
- Interchangeable, Space-Saving Square, 4-Tie-Rod Design
- Precision Honed Barrels

**MILLER FLUID POWER**
DIVISION OF FLICK-REEDY CORPORATION
2002-04 N. Hawthorne Ave., Melrose Park, Illinois

AIR AND HYDRAULIC CYLINDERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS • BOOSTERS

# NOW standard hand socket wrench or nut-runner drives THREAD CUTTING FASTENER

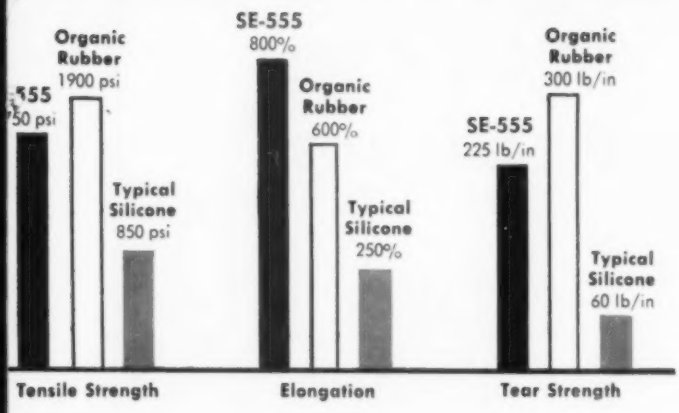
Specifically designed to hold die-cast or cold-forged name plates, emblems and trim against sheet metal surfaces . . . DOT's hex-head T.C.F. can be used in many other applications which require a spring take-up fastener (with integral washer) that pulls up tight without backup on flat or contoured surfaces.

It cuts clean, deep threads on unthreaded studs, even those that are chrome plated. Used on non-vertical studs, T.C.F. accomodates itself to any angle up to 20° from the vertical . . . and, when supplied with a pre-assembled plastic sealer, makes a water-tight seal. The sealer *precedes* the fastener onto the stud so that it is not damaged by the thread-cutting process.

T.C.F. is available *in quantity*, with or without sealer, to fit 1/8", 3/16" and 1/4" studs. Detailed drawings, dimensions and prices available on request.

## HOW TO SOLVE PRODUCT DESIGN PROBLEMS WITH

# GE SILICONE IDEAS



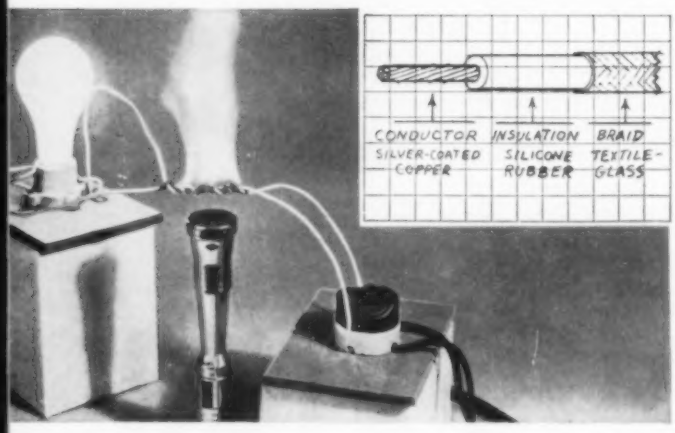

## HIGH STRENGTH RUBBER PARTS

**Problem:** *Organic rubber parts failing because of temperature extremes and ozone. High tear and tensile strength cannot be sacrificed.*

**Solution: Replace with SE-555—silicone rubber with tear and tensile strength comparable to organic rubber.**

SE-555 is a new silicone rubber with tear and tensile strength double that of ordinary silicone rubber (see comparative typical values at left). Whenever maximum resistance to weather and temperature extremes (minus 150°F to 500°F) is required, combined with high tear and tensile strength, specify SE-555. This is the only material available to rubber fabricators that meets AMS 3345 requirements for tear and tensile strength, elongation, heat resistance, compression set and low temperature flexibility. SE-555 can be fabricated in practically any color, including white.

You can order high strength silicone rubber parts immediately because SE-555 is available from stock for shipment to your fabricator. For more information and a list of qualified fabricators, mail the coupon below.




## HIGH TEMPERATURE WIRE INSULATION

**Problem:** *Find a wire insulation to withstand extreme conditions of temperature, moisture and ozone.*

**Solution: Wire insulated with G-E silicone rubber.**

Exposed to an 1800°F flame for hours, G-E silicone rubber insulation forms a non-conducting ash which still insulates. No toxic fumes are released, nor will it shrink and expose the conductor, as the laboratory demonstration on the left shows. Silicone rubber has superior dielectric strength at high temperatures and keeps it for years. It has unparalleled ozone resistance, stays flexible down to minus 75°F or lower. Use silicone rubber insulated wire wherever temperatures are extreme, and where an extra safety margin is needed. Examples: aircraft wire, Class B and H motor and apparatus lead wire, electronic hook-up wire and control cable. Want more information? Send in coupon below.

on steel coated with an alkyd aluminum finish, subjected to 1000°F for 2 hours.

Carbon steel coated with silicone aluminum finish, subjected to 1000°F for 24 hours.

## HIGH TEMPERATURE PAINTS

**Problem:** *Extend the life and appearance of metal surfaces designed for high temperature operation.*

**Solution: Special paints made with G-E silicones.**

Silicone based paints are finding increased application as corrosion-resistant or appearance-preservation coatings for many metals exposed to continuous temperatures as high as 1000°F. For instance, special aluminum-silicone paints often make it possible to use mild steel instead of stainless steel in industrial applications. High gloss silicone paints have proved to be amazingly durable finishes for heaters, appliances, etc. Gloss and color are retained up to 440°F, and the finish resists marring, scratching and chemical attack more than ordinary paints. Check into the performance advantages of high temperature silicone paints. Special paint formulations have been developed by leading paint manufacturers for specific temperature ranges and applications. For more data, fill in the coupon below.

**Write for more information . . .**

**GENERAL ELECTRIC**

**Silicone Products Department, Waterford, New York**

**Section D6A3, Silicone Products Dept.**
**General Electric Company, Waterford, N. Y.**

Please send me application data and names of suppliers of:

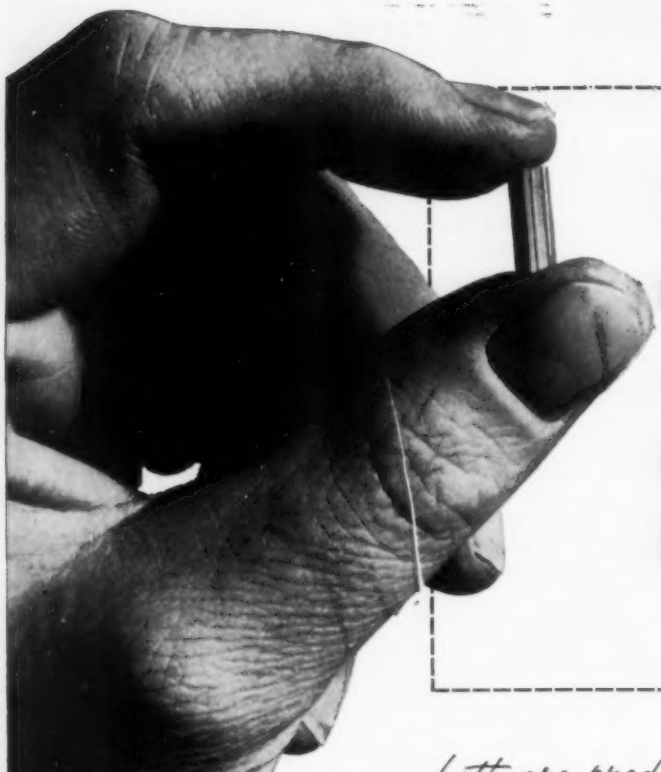
☐ Silicone rubber mechanical goods
☐ Silicone rubber insulated wire ☐ Silicone based paints

**Name**_____ **Title**_____

**Company**_____

**Address**_____

**City**_____ **Zone**_____ **State**_____



# 120,000 of these detonator plugs

*equal*

# one 73 lb. bumper strip

*both are products of*

## ORCO

# CUSTOMEERING

The precision pigmy component weighs less than $\frac{3}{10}$ of a gram and is an important part of a delicate detonator assembly. The 73-lb. bumper strip is a protective part of a "Dodgem" car in amusement parks.

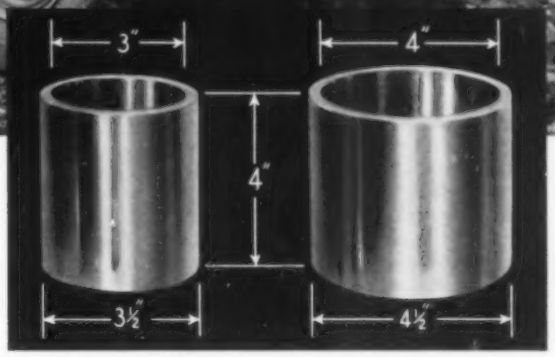
Big difference in size and application? Sure, but Ohio Rubber is recognized as a producer of "customeered" parts made from rubber, synthetic rubber, silicone rubber, polyurethane, and flexible vinyl, in *all sizes,* for any application, and whether molded, extruded, or bonded to metal.

From design through electronically controlled compound mixing and production facilities in four plants, Ohio Rubber's integrated set-up is prepared to handle your most exacting rubber and vinyl component requirements. Let ORCO engineers help on your next problem. See how ORCO CUSTOMEERING can work to your greater advantage.

Send for free booklet "Component CUSTOMEERING rubber and vinyl parts."

**THE OHIO RUBBER COMPANY**

A Division of The Eagle-Picher Company
Willoughby, Ohio




# OILITE

***SELF-LUBRICATING***

# BEARINGS

## prove a match for top payloads on ATHEY Rear Dump Trailers

Oilite* Bronze Bearings have proven more than a match for the 22 and 34-ton payloads on Athey Rear Dump Trailers.

Oil-cushioned against shocks and impacts, these Oilite heavy-duty bearings have demonstrated that they will withstand years of punishment and still give satisfactory service. They require only infrequent lubrication and help Athey substantially increase the dependability of its hauling units. Yet, Oilite Bearings *cost less* than many other type bearings!

No wonder more and more designers are specifying popular Oilite self-lubricating Bearings for motor vehicles, appliances, engines, power tools, machinery and countless other products.

Contact your local Oilite Engineer today. He'll gladly provide complete design information to help you make your bearing and bushing applications low-cost, dependable and maintenance-free. Look for him in your telephone directory under "Bearings—OILITE" or write direct to Dept. A-4.

TYPICAL PROPERTIES OF SELF-LUBRICATING BRONZE OILITE BEARINGS †

| | |
|---|---|
| Porosity, % | 18-23 |
| Ultimate Tensile Strength, (psi) | 18,000 |
| Compressive Strength (psi) | 20,000 |
| Elongation, % min. in 1" | 10 |
| Brinell Hardness | 40 |

† Other materials and physical properties available.

* REGISTERED TRADEMARK
ONLY CHRYSLER MAKES OILITE

*the most trusted name in powder metallurgy*

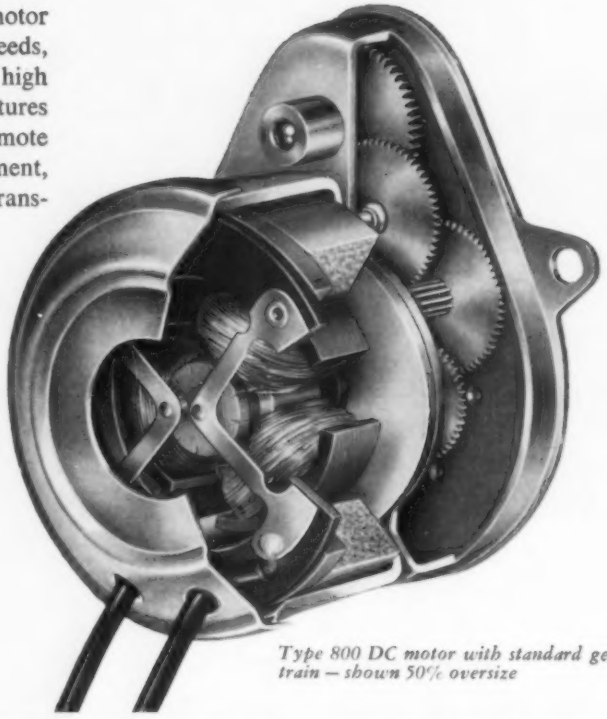
SINCE 1929 OILITE **AMPLEX DIVISION**

CHRYSLER CORPORATION, DETROIT 31, MICHIGAN

SELF-LUBRICATING BEARINGS • PRECISION PARTS • METAL FILTERS • FRICTION UNITS

# New high-torque low-current DC motor covers extended range of output speeds

The new Cramer Type 800 direct current motor offers an unusually wide range of output speeds, coupled with low current drain, high torque, high efficiency, and excellent speed stability. These features make it the ideal choice for timing devices, remote control equipment, recorders, signalling equipment, communications gear, displays, flashers, chart transports, and many other products.



*Type 800 DC motor with standard gear train — shown 50% oversize*

## Wide Performance Range

Depending on requirements of speed, torque, and voltage, the rotor is wound to produce a basic motor speed of 960 to 3000 rpm. A gear train then reduces this to the speed required at the output shaft. Low rotor speeds result in lower current drain at all speed-torque combinations, but limit the torque available at the higher output speeds. Higher rotor speeds require a somewhat higher input current, but greatly increase the torque available at the higher output speeds.

The Table at lower right illustrates this flexibility of design, with a few examples from the virtually unlimited range of performance characteristics which it provides. Where very low input current is required, and the supply voltage does not exceed 12 volts, the use of the low-speed rotor will provide 30 oz. in. at speeds below 3 rpm and 0.5 oz. in. at 200 rpm. The higher speed rotors meet the requirements of higher input voltages, and provide greatly increased torque at the higher output speeds with only a moderate increase in current drain. The high-torque motor has the additional advantage of speed stability within 10% from no-load to full-load, at speeds below 5 rpm.

The examples given in the Table are for illustration only. By correct choice of rotor winding and gear ratio, an unlimited number of operating specifications can be established throughout the entire range shown. The motor is also available without gear train, for output torques of 0.1 to 0.6 oz. in. at speeds up to 3000 rpm.

| OUTPUT SPEEDS WITH GEAR TRAINS | 960 RPM ROTOR LOW INPUT CURRENT *(3 to 12 volts DC)* | | 3000 RPM ROTOR HIGH OUTPUT TORQUE *(3 to 30 volts DC)* | |
|---|---|---|---|---|
| | INPUT VOLT-AMPERES | OUTPUT TORQUE OZ. IN. | INPUT VOLT-AMPERES | OUTPUT TORQUE OZ. IN. |
| 2 rpd | .16 | 30 | ..... | ..... |
| 1/6 rpm | .16 | 30 | .56 | 30 |
| 3 rpm | .35 | 24 | .64 | 30 |
| 10 rpm | .35 | 8.5 | 1.04 | 30 |
| 30 rpm | .35 | 3.0 | 1.72 | 21 |
| 60 rpm | .35 | 1.5 | 1.72 | 12 |
| 80 rpm | .35 | 1.1 | 1.72 | 8.5 |
| 200 rpm | .35 | .5 | 1.72 | 3.5 |
| 900 rpm | ..... | ..... | 1.90 | .8 |

*Typical Performance of Type 800 DC Motors for Minimum Input Current or Maximum Output Torque*

## Specifications

**SPEEDS** — 2 rpd to 900 rpm with gear train, 960 rpm to 3000 rpm without gear train.

**TORQUE** — 0.1 to 0.6 oz. in. without gear train, and to 30 oz. in. with gear train.

**CURRENT DRAIN** — as low as 30 milliamperes, depending on voltage, load and speed.

**VOLTAGES** — from 3 to 30 volts DC.

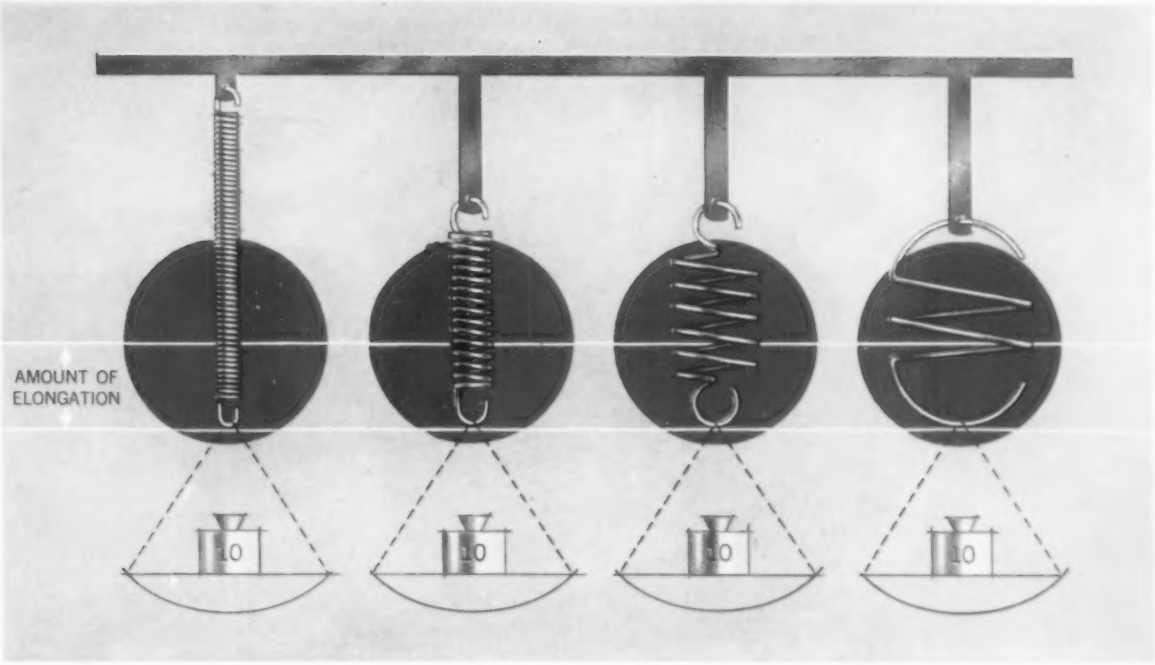
**REVERSING OPERATION** — with negligible speed difference, because of special motor design.

**GEARS** — precision-hobbed throughout, totally enclosed and with sealed-in lubricant.

*For your free copy of informative Bulletin PB-800, write:*

**CRAMER CONTROLS**
**CORPORATION**

Box 7, Centerbrook, Connecticut



# Spring shape and performance— or what does Spring Index mean?

One man distributes his 150 lbs. over a lean 6 ft. frame; another packs the same avoirdupois within a stocky 5 ft. 6 in. height. In a man, this might be expressed as the ratio of height to belt size. In a spring, it's a handy little ratio D/d, that of mean coil diameter to wire diameter. The illustration shows it quickly—same load—10 lbs.; same deflection—0.4 in. But in shape they range from the long thin spring at left with 75.8 coils and a spring index of 3, to the short fat spring at right with few coils and an index of 12. Application of the index ratio is particularly useful where space restrictions exist.

Our long years of specialization have developed many short cuts to spring specification to make your work easier. For general reference purposes write for pamphlet "Spring Design and Selection in Brief."

**Associated Spring Corporation**

General Offices: Bristol, Connecticut

Wallace Barnes Division, Bristol, Conn. and Syracuse, N. Y.
B-G-R Division, Plymouth and Ann Arbor, Mich.
Gibson Division, Chicago 14, Ill.
Milwaukee Division, Milwaukee, Wis.
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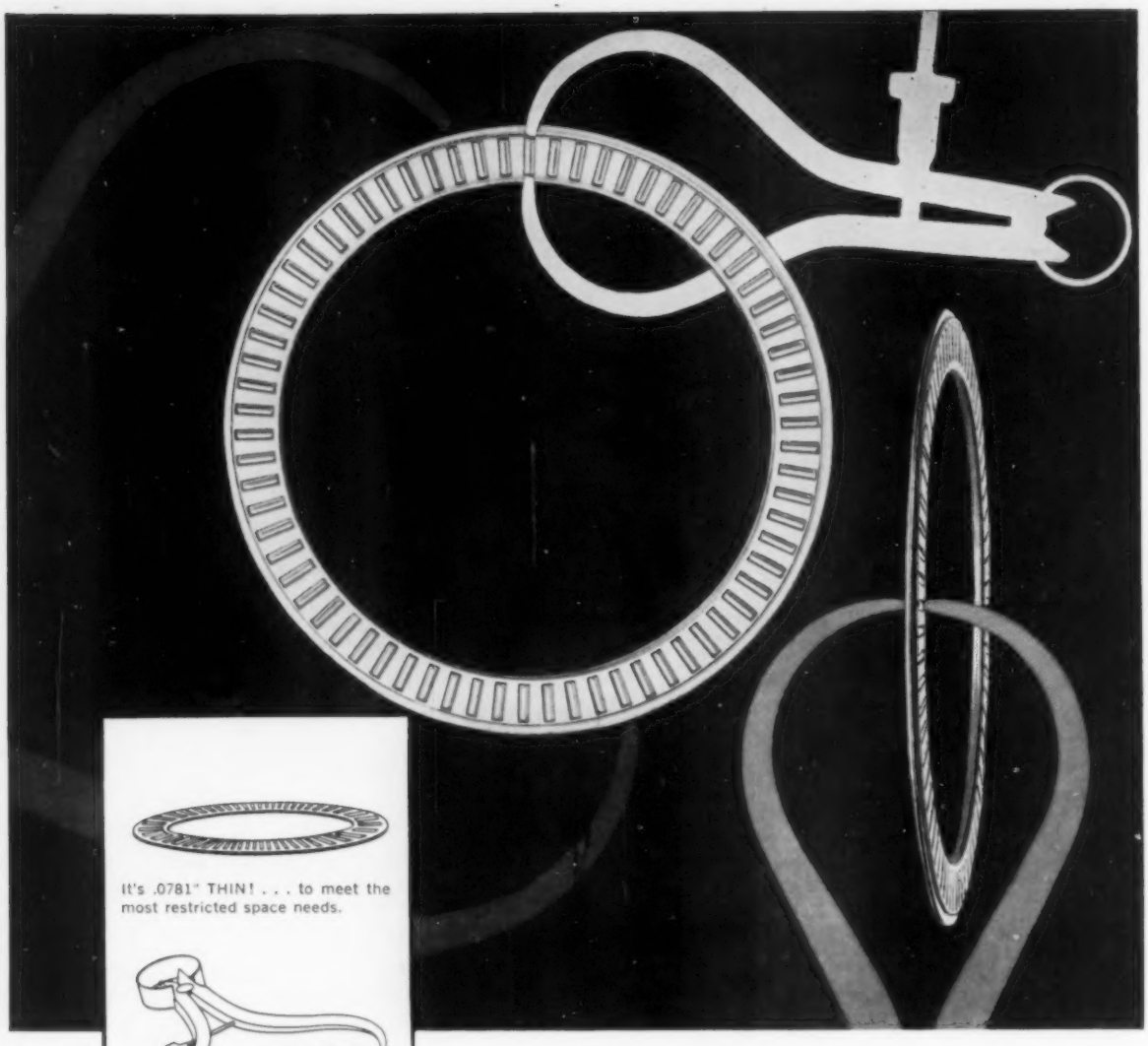
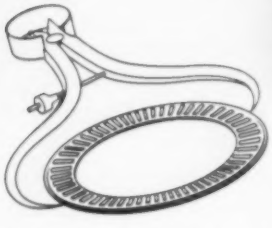




It's .0781" THIN! . . . to meet the most restricted space needs.



OD is much smaller, for given shaft size, than other types of thrust bearings.

Needle-proportioned rollers provide large contact area in minimum cross section.

# *By Every Measure . . . Ideal For Compact Thrust Applications*

Whether you gauge its value in compactness, high anti-friction efficiency, high thrust capacity, or low unit cost, you will find the new Torrington Needle Thrust Bearing measures up ideally to your needs.

This needle-type bearing is designed specifically for thrust loads in restricted space. It may run directly on adjacent hardened and ground surfaces or on standard thrust races. Used alone, or in combination with Torrington radial type Needle Bearings, the Needle Thrust Bearing finds wide use in many applications including steering gears, hydraulic pumps, tractor bolsters, bevel and worm gear boxes, governors, outboard motors, 2-cycle engines, washing machines, power tools, torque converters, and automatic transmissions.

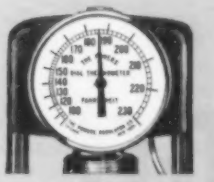
For engineering information and assistance in design, please call upon the services of Torrington's Engineering Department. **The Torrington Company, Torrington, Conn.—and South Bend 21, Ind.**

## TORRINGTON BEARINGS

*District Offices and Distributors in Principal Cities of United States and Canada*

**NEEDLE • SPHERICAL ROLLER • TAPERED ROLLER • CYLINDRICAL ROLLER • BALL • NEEDLE ROLLERS • THRUST**

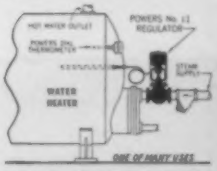
# WHY POWERS No. 11 REGULATORS Give BETTER CONTROL and Last Longer



**Temperature Indicating Regulator**

A Versatile Control for hundreds of applications. Has big 4" easy to read dial thermometer. Gives visual proof of constant temperature control. Helps to accurately adjust the regulator. *A feature originated by Powers in 1930.*

Simplest, Reliable
**TEMPERATURE CONTROL**
made for: Many Industrial Processes, Heat Exchangers, Air Compressors, Diesel Engines, Fuel and Crude Oil Heaters and Treaters.



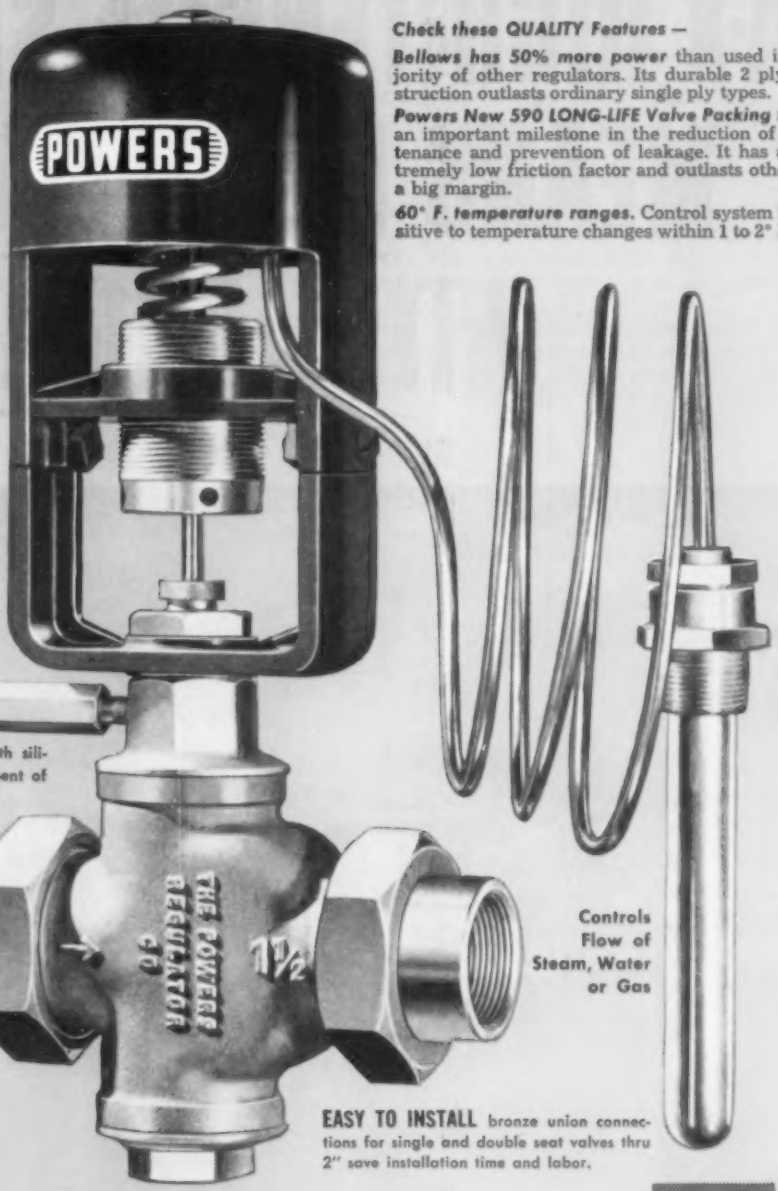

**SELF OPERATING**

***Check these QUALITY Features —***

***Bellows has 50% more power*** than used in majority of other regulators. Its durable 2 ply construction outlasts ordinary single ply types.

***Powers New 590 LONG-LIFE Valve Packing*** marks an important milestone in the reduction of maintenance and prevention of leakage. It has an extremely low friction factor and outlasts others by a big margin.

***60° F. temperature ranges.*** Control system is sensitive to temperature changes within 1 to 2° F.




**Valve Stem Lubricator** with silicone grease aids easy movement of highly polished stainless steel valve stem.

Balanced (Double Seat) Valve

Controls Flow of Steam, Water or Gas

**EASY TO INSTALL** bronze union connections for single and double seat valves thru 2" save installation time and labor.

(c44r)

Above: Flanged Iron Body Valve with Double Seat for sizes above 2"

**Use Powers 65 years of experience and engineering know-how** to help you select the right type temperature regulator and right size valve. From our complete line of self operating regulators and air operated temperature controllers you can be sure of getting the control best suited for your requirements.

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**THE POWERS REGULATOR COMPANY**

For whatever you make . . .

# N-A-X® HIGH-TENSILE STEEL MEANS LIGHTER WEIGHT WITH LONGER LIFE

Light weight and shallow draft make the ideal commercial river barge. Thanks to the inherent qualities of N-A-X HIGH-TENSILE steel, this river barge designed and built by Nashville Bridge Company, Nashville, Tennessee, offers a weight reduction in excess of 10% over mild carbon steel—plus longer life and increased payload capacity with shallower draft.

Operators like the way weight-saving N-A-X HIGH-TENSILE improves barge towing efficiency—less draft when loaded; less dead weight to pull when empty. That means savings on operating costs all the time. And, again thanks to N-A-X HIGH-TENSILE, barge operators get more resistance to corrosion. For this manufacturing job, like so many others, N-A-X HIGH-TENSILE steel provides desirable lightness with greater durability and strength.

**Check These Important Advantages for Your Job:** The N-A-X HIGH-STRENGTH steels—both N-A-X HIGH-TENSILE and N-A-X FINEGRAIN—compared with carbon steel, are 50% stronger • have high fatigue life with great toughness • are cold formed readily into difficult stampings • are stable against aging • have greater resistance to abrasion • are readily welded by any process • offer greater paint adhesion • polish to a high luster at minimum cost.

Although N-A-X FINEGRAIN'S resistance to normal atmospheric corrosion is twice that of carbon steel, N-A-X HIGH-TENSILE is recommended where resistance to extreme atmospheric corrosion is important.

For whatever you make, from steel shop boxes to steel river barges, with N-A-X HIGH-STRENGTH steels you can design longer life, and/or less weight and economy into your products. Let us show you how.

This barge, built by Nashville Bridge Company, hauls hot asphalt between Baton Rouge and other points along the Mississippi-Ohio River system. Both the barge hull and the cargo tanks are made of N-A-X HIGH-TENSILE. Weight reduction: in excess of 10% compared with mild carbon steel.

N-A-X HIGH-STRENGTH STEELS

N-A-X Alloy Sales Division, Dept. C-2

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Detroit 29, Michigan • Division of

NATIONAL STEEL CORPORATION

N-A-X Alloy Sales Div., Dept. C-2

Great Lakes Steel Corp., Detroit 29, Michigan

☐ Please send me 12-page illustrated technical catalog on N-A-X HIGH-STRENGTH steels.

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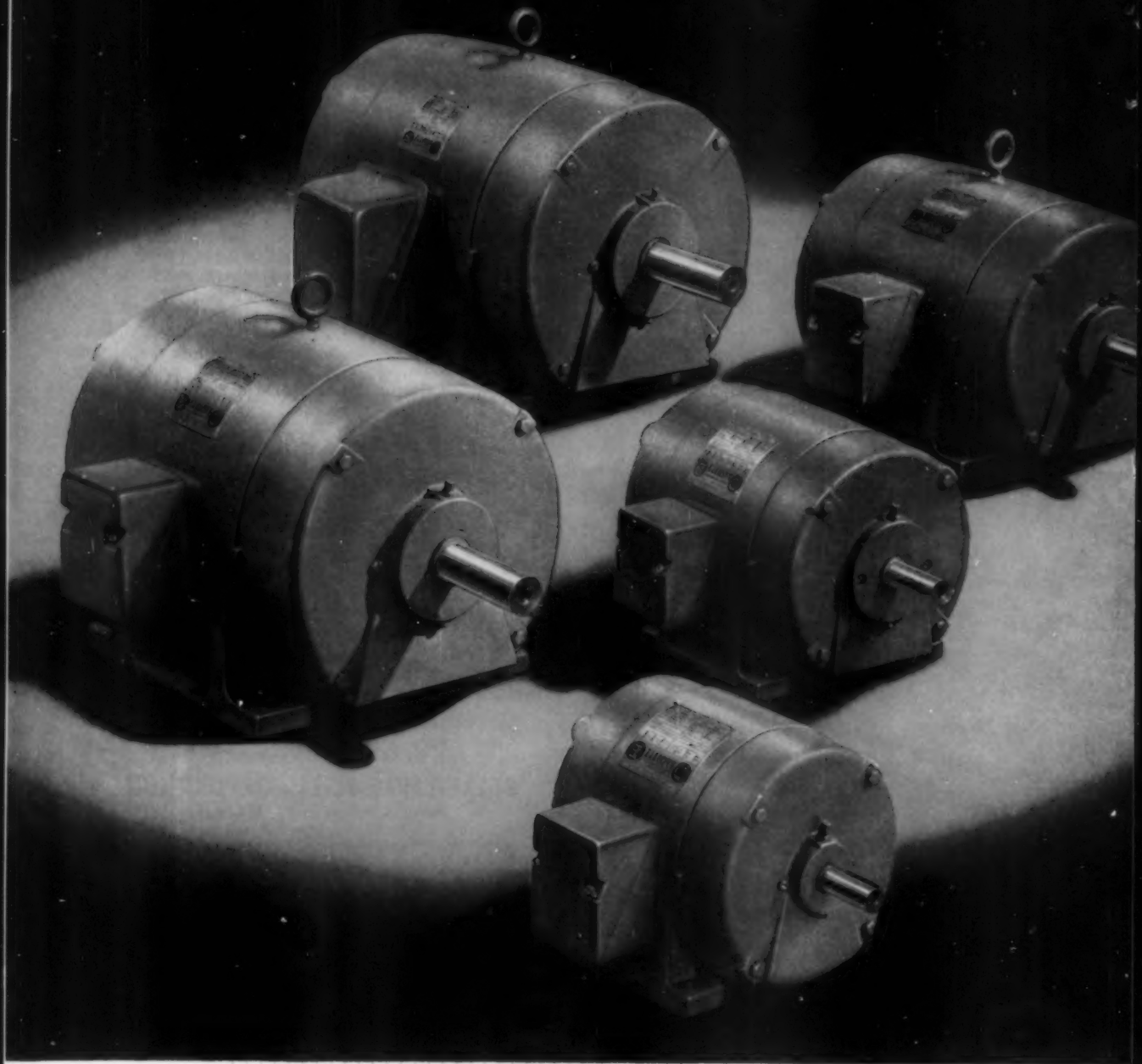
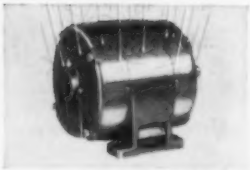
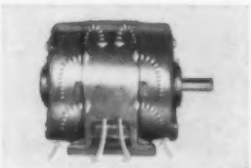
# ELLIOTT C-W PROTECTED MOTORS



## THESE DESIGN FEATURES ASSURE PROTECTION, DEPENDABILITY, LONG LIFE . . .



Exceptional protection is afforded by Elliott C-W frame construction. Standard motor is dripproof; essentially splash-proof as well.



Cooling air is brought into the motor from both ends, directed over coil ends and along coils, then forced out through bottom openings.

The extra dielectric strength, mechanical toughness, and resistance to moisture and corrosion of Elliott C-W coil insulation materials gives added dependability.

# *these compact designs provide*

# EXCEPTIONAL protection

# DEPENDABLE operation

# SIMPLIFIED maintenance

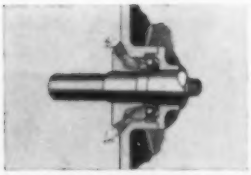
The enclosure of the Elliott C-W "dripproof-protected" motor provides a high degree of protection. Cooling air inlets and outlets are so located that the motor is not only completely dripproof, but essentially splashproof as well.

Frames, end brackets, and conduit boxes are made of high-strength cast iron, capable of withstanding considerable mechanical abuse. Motor life is prolonged and greater dependability assured by the use of the most modern synthetic insulating materials. Where maximum protection is required, totally-enclosed or explosion-proof designs are available.

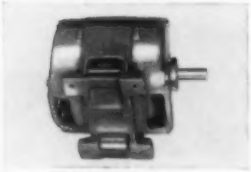
**ELLIOTT Company**

**CROCKER-WHEELER PLANT, Jeannette, Pennsylvania**

*Write for Bulletin PB 6000-6 which describes in detail the features which make Elliott C-W motors outstanding.*



New grease flushes old through bearing and out drain. Inner grease reservoir and inner cap guard against rust or corrosion of bearing. Prelubricated cartridge-type bearing optional.



The mechanical design includes long bracket fits, sturdy feet, which are cast integral with the frame, handy bracket knock-off lugs, large conduit boxes for easy wiring.

W8-1

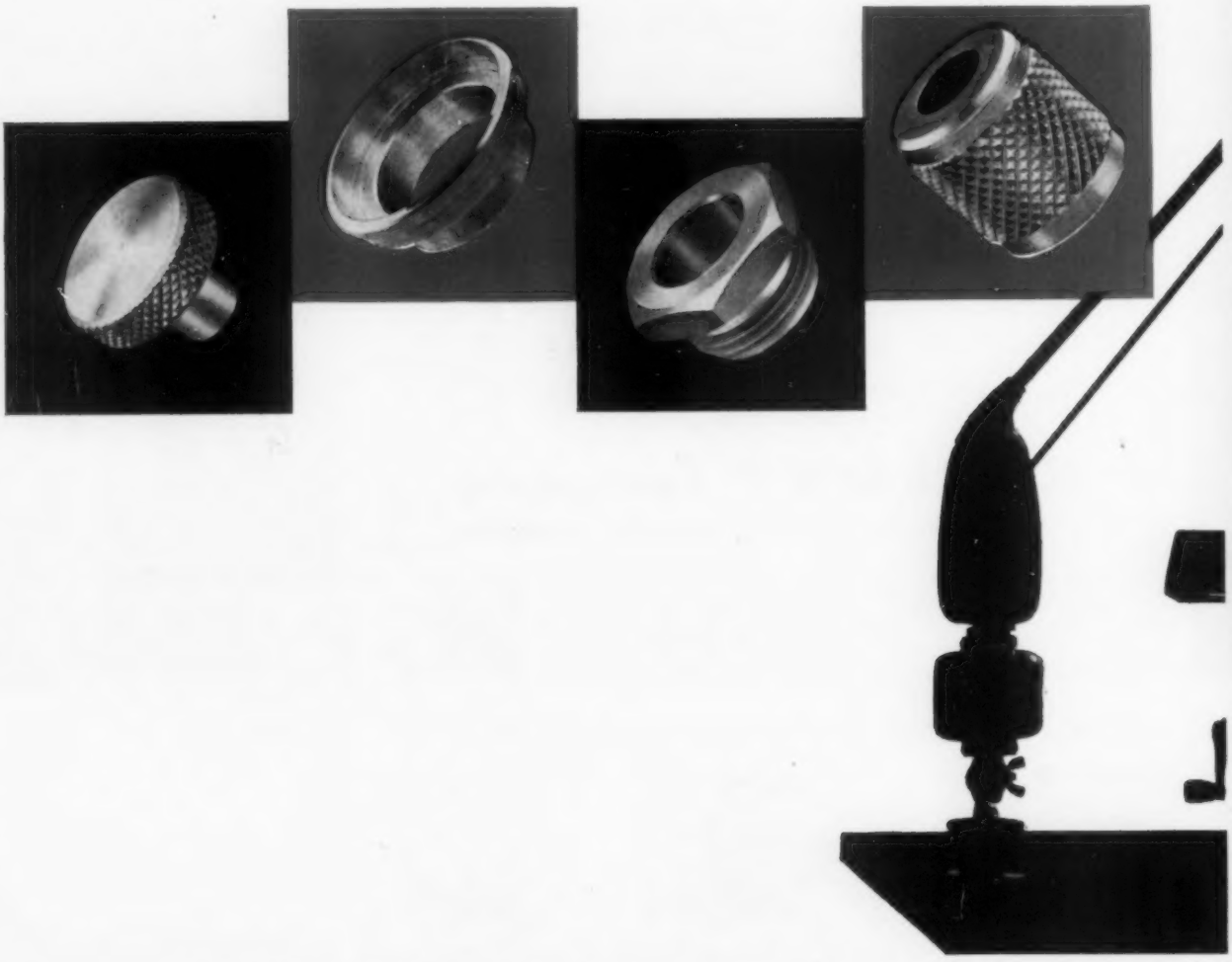
# WHAT THE DESIGNER CONCEIVES . . . ALUMINUM ACHIEVES

**ALUMINUM'S PRESENT WIDE USE** and its increasing importance in all types of fabricating are helping create advanced concepts throughout the fields of metalworking and design.

For screw machine production in particular, aluminum machining has pointed the way to new, better and faster methods of parts production for all ferrous and non-ferrous metals. For example—thanks to aluminum—speeds of equipment are common today which a few years ago would have appeared almost unbelievable.

What are the advantages of screw machine production? To help designers make full use of up-to-date developments, the following checklist presents 12 advantages of modern screw machine production:

1. Starting material is a wrought product which gives high properties in the finished part.
2. Very fine threads possible—as well as accurate threading.
3. Excellent finishing possibilities—anodizing, etching, buffing, etc. As-machined finish gives very fine surface.
4. Closer tolerances and more intricate parts possible than with other methods. Mating parts match better.
5. Excellent concentricity is guaranteed.
6. Fewer rejects for porosity when compared to a cast part.
7. Lower costs for production tooling, dies, set-up; faster delivery of finished parts possible due to fast availability of tooling, speed of set-up.
8. Modification of parts in production easier and less costly.
9. Wide range of equipment and facilities available throughout the country.
10. Fewer secondary operations necessary; possible to avoid secondary finishing by using the as-machined surface.



11. Lower costs for actual production due to high rates of production with available new equipment.

12. Lower costs for finished parts due to competitive pricing among large number of suppliers.

**ALUMINUM IN SCREW MACHINE PRODUCTION** offers designers more useful properties than any other metal. Check this list of 12 aluminum advantages:

1. Light weight—moving parts present less resistance to applied force, wear less; chips float out of recesses better for cleaning finished parts. Easier handling of raw material in plant, lower freight costs on finished parts.
2. Non-magnetic.
3. Corrosion resistant—can often eliminate finishing.
4. Non-sparking.
5. Lower raw material cost per part.
6. Greater conductivity—helps dissipate machining heat.
7. Some alloys less susceptible to radiation absorption.
8. More alloys available than some other metals, allowing a particular alloy to be related to a particular part.
9. Less price fluctuation on raw materials.
10. Stock readily available. Size range broad and well stocked at distributors throughout the country.
11. New procedures in producing aluminum screw machine stock now give greater tool life and higher production. New processes such as Electrofilming and Kanigen Coating also have overcome old problems such as galling and binding.
12. Technical literature for designing purposes readily available.

For further information and expert assistance, call the Kaiser Aluminum sales office or distributor listed in your telephone directory. Kaiser Aluminum & Chemical Sales, Inc., *Executive Office*, Kaiser Bldg., Oakland 12, California; *General Sales Office*, Palmolive Bldg., Chicago 11, Illinois.

See "MAVERICK", Sunday Evenings, ABC-TV Network. Consult your local TV listing.

For The Competitve Edge, Go Aluminum

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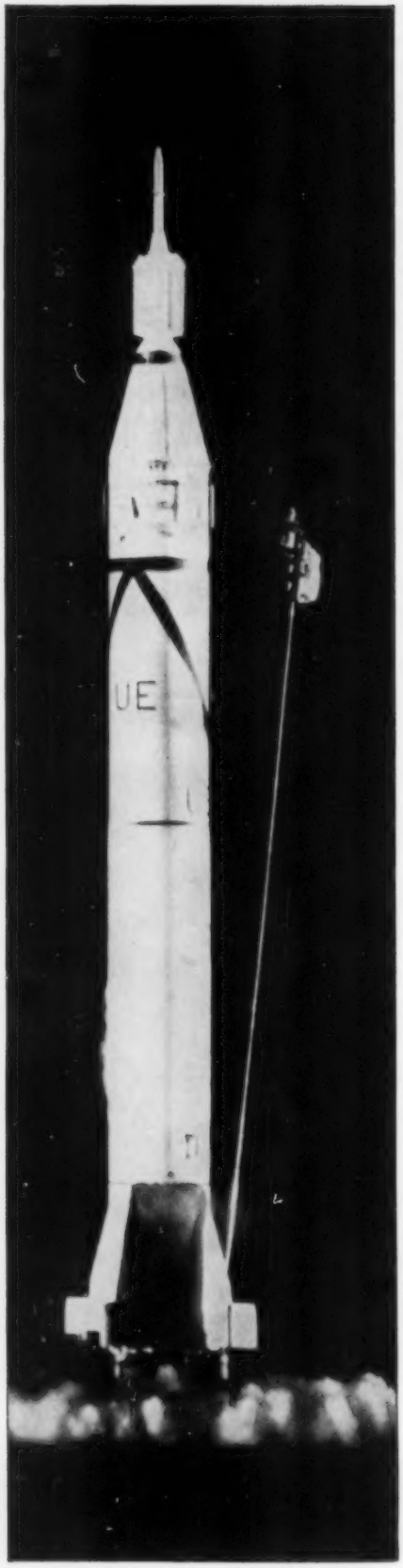
THE BRIGHT STAR OF METALS



# Republic Stainless Steel Circles the World

When "Explorer I" was successfully placed in orbit by the U.S. Army from Cape Canaveral on January 31, a new era was opened for the use of Republic ENDURO® Stainless Steel.

Vital instruments in the nose section of the satellite are protected by a cone of stainless steel produced by Republic. This nose cone was fabricated from Type 430 by The Lodge and Shipley Company, Cincinnati, Ohio, using the Floturn Process. By flow-turning, the wall thickness of the cone can be increased in specific areas to comply with design requirements of high temperatures or stresses.

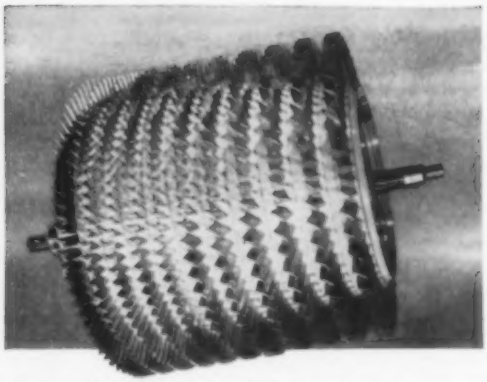
Stainless Steel is highly ductile. It is readily formed into desired shapes by cold-forming, drawing, and bending operations. It provides low thermal expansion and is highly resistant to atmospheric corrosion, erosion, and oxidation at high temperatures.

Republic is the world's largest producer of stainless, heat-resisting, and alloy steels. As rapid developments in the fields of supersonic aircraft and missiles increase demand for these high-strength, select formula steels, Republic is keeping pace through research and new production facilities.

Our metallurgists and engineers are always available, without obligation, to work with your personnel in using Republic Stainless Steels, Heat-Resisting Steels, Alloy Steels, and Titanium to best advantage. Check and mail the coupon if you would like a Republic specialist to call at your plant.

Official U.S. Army photograph shows launching of Jupiter-C Missile and "Explorer I" Satellite from Cape Canaveral, Florida, 10:48 PM, EST, January 31, 1958.

"Explorer I" is positioned on spin launcher. The satellite is spin-stabilized in much the same manner as a rifle bullet. Rotational spin of more than 700 RPM was started on the ground before the satellite was launched. In this Official U. S. Army photograph, the striped area at the top of the Explorer indicates the nose cone fabricated from Republic ENDURO Stainless Steel, Type 430.



**REPUBLIC ALLOY STEEL** provides high strength and dependable toughness in jet engine compressor rotor discs. In Pratt & Whitney's J-57 jet engine, Republic Hot Rolled Alloy Steel, AMS 6415 (AISI 4340), furnishes the highest strength values—plus an exceptionally high strength-to-weight ratio that permits the design of thinner, lighter sections to save weight and hold down size without sacrifice of strength or safety. The discs are machined from forgings by the Jet Division of Thompson Products, Inc. Forgings are supplied by Wyman-Gordon Company.

**REPUBLIC TITANIUM** is currently being used for many applications in both aircraft and missiles. Because of its high strength and weight saving factors, titanium has replaced other materials normally used for firewall and nacelle construction. In missiles and rockets it has almost unlimited applications. Titanium's extremely high corrosion-resistance makes it attractive for tanks to hold acids used in combination with missile fuels. Nitric acid, for example, has negligible effect on titanium. It is practically immune to salt water and sea air corrosion. Send coupon for more facts.

# REPUBLIC STEEL

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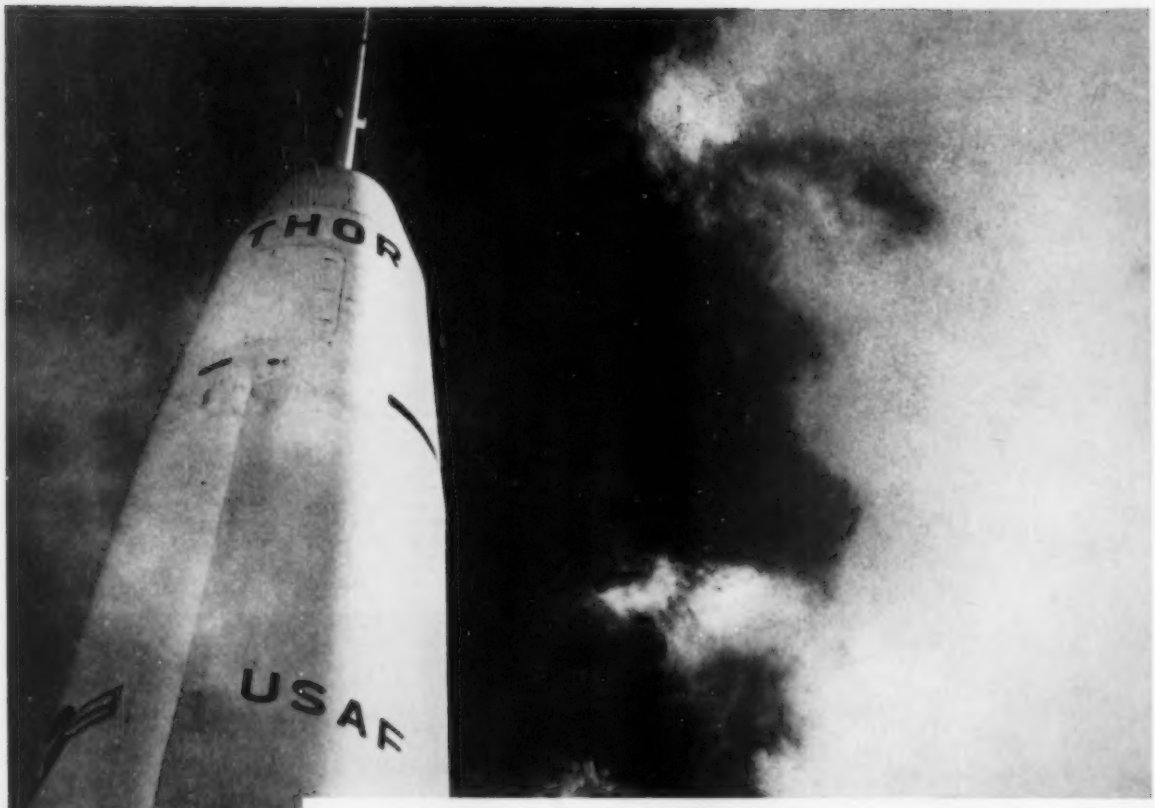
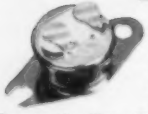



# KLIXON THERMOSTATS

## *help assure reliability of*

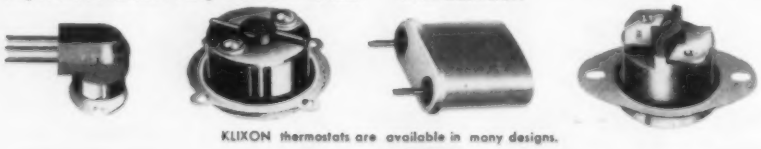
## BALLISTIC MISSILES



Among the hundreds of vital parts required for ballistic missiles are several KLIXON Hermetically Sealed Thermostats. Spencer Division supplies thermostats to the General Electric Company's Missile and Ordnance Systems Department, developers of the nose cone for the Air Force's THOR IRBM.

KLIXON snap-acting controls are ideal for applications of this type — for several important reasons. They are small in size and light in weight; they respond to temperature change quickly and with accurate repeat performance; they have ample capacity to handle heavy electrical loads; and their calibrations stand up in the face of severe environmental conditions.

That is why more and more manufacturers of all kinds of equipment choose KLIXON controls with confidence — why you, too, should investigate the KLIXON line for application possibilities in your products. Write today for THSN technical data bulletins.



KLIXON thermostats are available in many designs.

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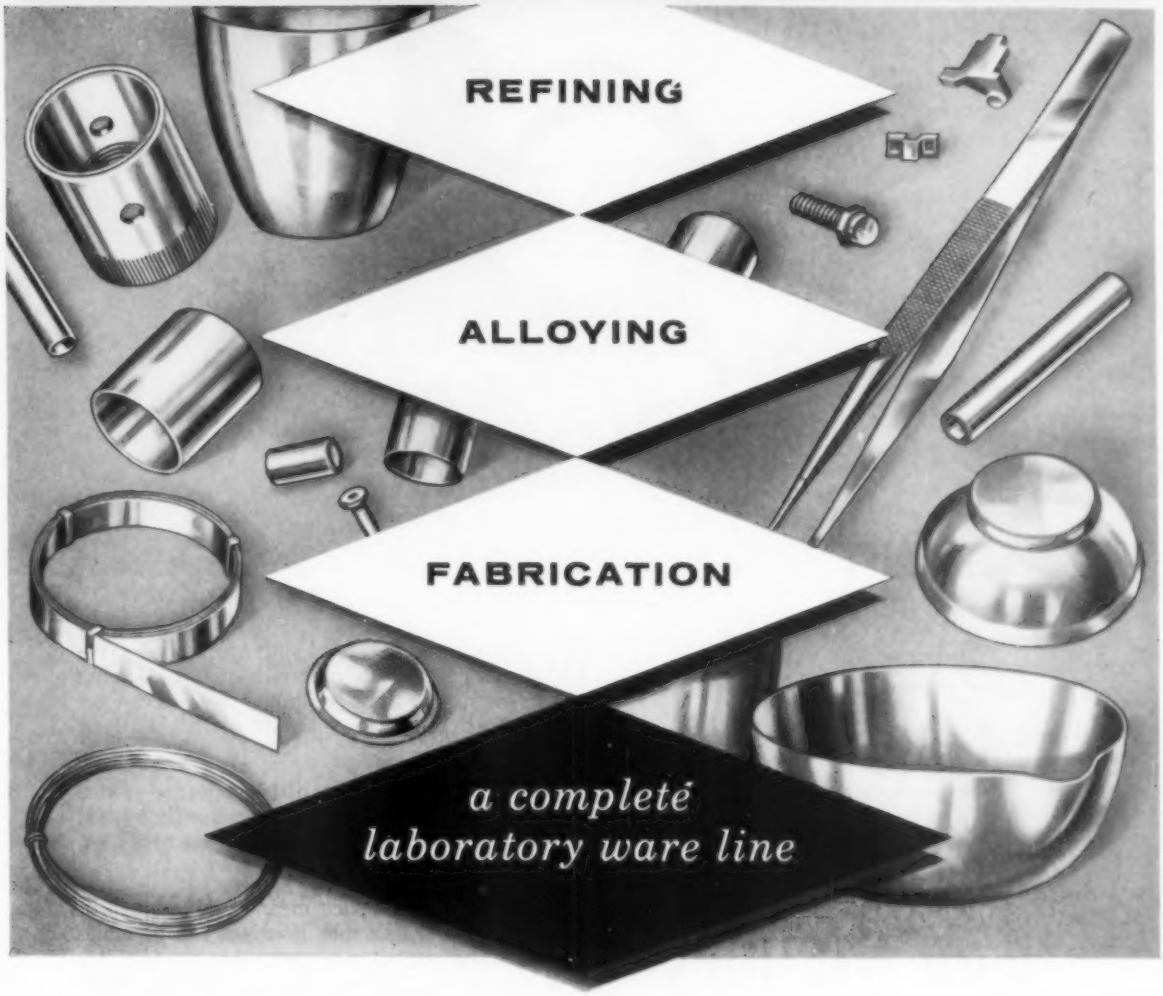
*Spencer Division* 3804 Forest Street, Attleboro, Mass.

KLIXON®

# *General Plate Platinum Facilities now offer you...*




General Plate offers platinum group metal users some of the most modern and complete facilities in the industry — facilities that can serve you in many ways.

General Plate also offers a complete line of Platinum Laboratory Ware. This laboratory ware features fused double thickness rims and extra heavy bottoms for added wear resistance, providing longer service life than ordinary laboratory ware.

*Here's how General Plate can serve you in platinum group metals. We do these things:*

- Assay and refine platinum-group metals
- Recover and rework materials previously expended in use
- Produce chemical compounds for catalysts and for electroplating solutions
- Alloy platinum-group metals
- Produce solid and clad platinum group metals as sheet — foil — wire — tubing — gauze
- Fabricate electrical contacts and contact assemblies for switches, relays, instruments, controls and other applications — all to meet your specifications accurately

The cost of many platinum applications can be greatly reduced through the use of platinum clad metals — available in sheet, wire, tubing, foil and gauze.

*You Can Profit By Using General Plate Clad Metals. Write for literature today.*

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# *More Weight in Less Space with* Mallory 1000 Metal

WHATEVER the nature of your assembly—gyroscope rotors, counterbalances, balancing weights, or similar mass components—you can get more weight into less space with Mallory 1000 Metal.

Mallory 1000 has a density of 16.96 gm/cc—twice that of brass or steel, and is far stronger than lead! It features ready machineability—even to a high surface finish.

More weight in less space means real savings in several ways. For example, housings can be made smaller—thus overall assemblies become smaller for a savings in cost and weight. Mallory 1000 Metal provides exceptionally high inertia in a smaller space, increasing the sensitivity of gyroscopic or balancing action, yet reducing the overall unit size.

Complete information on Mallory 1000 Metal specifications and applications may be had on request. Write today.

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**For information on titanium developments, contact Mallory-Sharon Titanium Corp., Niles, Ohio**

# DEVELOPMENTS TO WATCH...

## An "electronic heat engine" to convert . . .

. . . atomic, solar, or conventionally produced heat directly into electricity has been designed by two MIT professors, and a company is being formed to put it to work.

Basically, they say, it's a simple device that takes advantage of the fact that if two metal plates are placed side by side and one is made hotter than the other, electrons will jump from the hot plate to the cold plate, forming a stream of electricity.

In their experimental models, they encase the two plates in a vacuum tube and hold one plate at 2200 F, while the other (the "cold" plate) is at 1000 F. A wire outside the tube connects the plates to an external load where the energy is put to work.

This device has produced electric power with a thermal efficiency of about 12%; and the professors believe another thermoelectron engine they've designed, which uses crossed electric and magnetic fields to control the flow of electrons, will do even better. "Even on the basis of the current model," they predict, "it appears that a relatively efficient power plant can be built to yield from 5,000 to 15,000 w per cu ft of total plant volume, with a probable thermal efficiency of better than 10%." Furthermore, they say, "isotope heating is a very promising possibility for the near future."

## Foamed ceramics . . .

. . . for sandwich-construction core materials are being developed under Wright Air Development Center sponsorship. Ohio State University Research Foundation has been testing both mechanical and thermal bloating processes for high-wollastonite (calcium metasilicate) materials. "Mechanically bloated wollastonite covered with zircon skins . . . has excellent properties," they say, and the fire-bloating process "might be useful in producing the ceramic equivalent of a foamed-in-place core."

Wollastonite foams are not without their drawbacks, though. At the present stage of development, strength, thermal shock resistance, and stability (of the mechanically bloated material, at least; the fire-bloated type is still being tested) leave something to be desired. However, OSURF notes that fire-bloated shapes of Pyrex glass were successfully fabricated (using lamp black as the bloating agent), and suggests that such materials as aluminum and zircon also be tested.

(For more information on sandwich construction, see *PE*—April 27, p. 80; and for a note on foamed metal and its possible use for sandwich cores, *PE*—Nov. 18, '57, p. 17.)

## Pinhead-sized semiconductor diodes . . .

. . . that could pave the way for "pocket-sized" electronic computers are in pilot production at Pacific Semiconductors, Inc., Culver City, Calif. A new sealing process, using a thin coating of glass-like material bonded directly to the semiconductor surface in place of the usual package, is the key to the development. But Pacific also claims to have reduced leads, contacts, and the core itself "to their essentials" and to have devised improved methods for attaching the leads to the semiconductor.

Although the pilot line is operating successfully, Pacific thinks it will be a year or more before these "Tiny Tim" silicon diodes can be supplied in commercial quantities. Production engineering is, however, under way.

**Miniaturized diode** is compared with conventional diode and tube. With new device, Pacific says it should be possible to pack an entire radio circuit in less space than the vacuum tube alone now requires.

# DEVELOPMENTS

## TO WATCH...

## Add another new semiconductor device . . .

. . . to the burgeoning list of diodes, transistors, thermistors, and spacistors (see p. 33, and *PE*—Apr 14, '58, p. 60). This newest one, just announced by Bell Labs, is classed as *field-effect varistor*. It's a two-terminal semiconductor, specifically designed for use as a current-regulator or limiter, but BTL says its high impedance means it can also serve as an ac switch. (Varistors, in contrast to transistors, are passive, voltage-dependent devices, showing nonlinear resistance.)

In the new field-effect varistor, there is a single planar junction (created by diffusion), so arranged that current passes parallel to it, through a constricted area or channel. This device shows two voltage-dependent transistion points: As the voltage increases, the current increases until the first transition or "pinch-off" point is reached. Then, over a considerable voltage range, it shows no response, holding a constant current until the second transition or "breakdown" point is reached. This plateau of constant current can extend over a voltage range as great as 10 to 150 v, with a current of 1 ma; and a range of 10 to 25 v with a current of 10 ma. Over most of this range, current can be held within 1%.

## First successful cold extrusion of titanium . . .

. . . is claimed by Battelle Memorial Institute, which terms it "a major step in the development of economic methods for producing hollow aircraft parts." Using a 700-ton hydraulic press and two-way extrusion (forward and back), Battelle engineers say they've been able to turn 1½-in. slugs into cups up to 3 in. long with wall thicknesses down to 0.22 in.–a 50% reduction. Surface finish is comparable to smooth machine turning, Battelle says, and the tensile strength of unalloyed titanium is increased as much as 30%. Other mechanical properties also improve.

Battelle engineers also believe a good deal more could be done with forging techniques for titanium, though they note that, during the past three years, a good deal of progress has been made. Here, the greatest needs are for larger equipment (particularly for cored forgings), and for a better understanding of metal flow in intricate shapes.

## Self-lubricating bronze parts up to 12 in. . . .

. . . in over-all length, and with a tensile strength of 20,000 psi are being produced by a new process at Metal Powder Fabrications, Ltd, Staffordshire, England. Furthermore, the company says, the parts have an elongation of 5% and show no compression set at pressures of 2,000 psi, and no more than 0.02 at 10,000 psi. So far, no stock parts have been made, but the company says it is ready to supply strip, plates and cylinders to specifications and is welcoming inquiries.

## Oil filters that capitalize on static electricity . . .

. . . instead of considering it as a nuisance have been designed by Acme Plastics Products. In this case, the static electricity is that normally found in plastics.

Its advantage is that its electrical charge helps to retain fine particles that otherwise might be recirculated in the engine. Other advantages of the design, the company claims, is that it offers multiple filter traps and settling areas, yet is actually smaller than most metal catridges. Material used here is Tenite cellulose acetate butyrate.

**New all-plastic oil filter cartridge** uses plastics' static electrically to help trap and hold fine particles of dirt, grit and dust. —ARG

# Army's Maintenance Problem: How to Keep Things Simple

- **Keeping spare parts in supply system costs $2000 per year per part, exclusive of part cost.**
- **Self-correcting, self-testing needed more and more as equipment for modern defense systems increase in complexity.**
- **Throw-away and quickly replaceable modular units are design concepts getting increased attention.**
- **Maintenance people work with R&D and product development groups right up through the product engineering stage.**

Logistics, that branch of the military art that has to do with the transport and supply of troops, has, by the Army's own admission, been the cause of failure or curtailment of military tactical operations more often than has enemy action. Getting equipment to the right spot at the right time always is a major problem. But perhaps even more difficult is the problem of keeping this equipment in good working order. Adequate spare parts are a necessity, as are the technicians to do the job.

This, then, poses the problem: how to design the equipment, which is becoming more and more complex, with both the spare parts to keep it in operation, and how to keep the number of technicians to maintain it at the absolute minimum.

The Fire Control Instrument Group of the Frankford Arsenal has developed concepts for a Modern Army Maintenance System with which they hope to reduce the burdens on their present logistic system. The system will be capable of high mobility, with a reduction of line items of supply and reduction of highly skilled maintenance men in the combat zone. In this latter respect, the Ordnance Branch of the Army is no different than other branches of the military: retaining skilled people in the maintenance branch is always difficult, since more lucrative jobs are available outside the military. The goal, then, is always to make maintenance more simple.

Keeping a supply of spare parts for even the smallest component is an expensive business. Frankford Arsenal says it costs them $2000 per year to maintain any item, like a small spring for a special switch, in its supply system. This figure consists of all the overhead expenses such as the effort to buy the item, its storage, shipping costs to various depots, cleaning, inventories, paper work coming back from the field to requisition the item, etc. It does not include the initial cost of the item, nor the labor necessary to install it.

Consolidating parts into modular units both for quick and simple replacement offers a solution to the problem, and is a design concept being stressed. However, the more simplification of operation and maintenance that is built into a piece of equipment, the more complex is the design of the equipment.

For example, many more self-checking features must be built-in, because reliability of the equipment cannot be sacrificed at the expense of simplified maintenance and operation. Self-correcting and self-testing of fighting equipment are common terms today.

An example of how spare parts can hamstring a maintenance operation: the M-33 integrated fire control system for 90 mm and 120 mm consisted of some 48,000 parts, 6,800 of which had to be kept in storage. When this system was developed, modular design was not used to any great extent. It is estimated that with redesign today, these 6,800 required spare parts could be reduced by one-half.

The switch to missiles in our defense system is making the design-for-simplified-maintenance concept difficult. Frankford Arsenal says major problems include: complexity of equipment because of stringent demands for accuracy; the huge quantity of equipment required to maintain one battery.

### THROW IT AWAY

Design-for-throw-away is another design concept being used more and more to simplify maintenance as well as ease the supply burden. The concept is used extensively with electronic gear where complete circuits sub-assemblies are removed and thrown away and replaced by another plug-in unit. But the concept is being used elsewhere by Army Ordnance.

The Sight M39 used on the 3.5 in. rocket launcher is now in the throw-away category. In the type field army, which would consist of about 400,000 men, there would be roughly 12,000 M39 Sights. Stocked as a maintainable item, it would require 23 parts items in the supply system from the depot level to the user. It is estimated that four hours would be the average rebuild time required. Rebuilding for each sight is required on the average of once a year, or 6,000 man-days per year to support a type field army.

Besides eliminating the spare parts storage problem and the repair time, savings by switching to design for throw-away were realized in: the elimination of technical and rebuild manuals, technical preparation of publications, printing and distribution costs, preparation of contract specs for the eliminated line items, costs involved in awarding and monitoring contracts, storage and transportation costs, etc., and the elimination of specialized training of maintenance personnel.

### WATCH REPAIR BILL CUT

A throw-away wrist watch also is being investigated. For a type field army of 400,000 men, 27,000 watches of all types would be used. About 24,000

would be wrist watches. Maintenance of all watches at the depot level would require 675 different repair parts with a total dollar value of $940,455. Twelve technicians would be required for this work.

No maintenance is planned for the throw-away type watch except for the replacement of bands. The watch will be a non-jeweled, shock proof, magnetic resistant unit in a plastic, waterproof case which cannot be disassembled for repair. The Army hopes to obtain such a watch for from $5-7. Elimination of wrist watch repair will cut 375 lines of repair parts in the supply system. However, for the two models of Railroad-type watches and the stop watch which will remain in the system, 295 line items of repair parts, plus tools will be needed for maintenance.

### THROW-AWAY ENGINE

The Army's Ordnance Tank Automotive Command in Detroit is studying a number of pieces of automotive equipment for possible throw-away design. In many instances it has been found to be cheaper and faster to throw away a component than try to repair it in the field. Example: carburetors; a long-lived transistorized voltage regulator; truck and tank engines; repair kits.

Engines for all combat vehicles will be designed to last the expected field life of the vehicles. In tanks this is about 5000 miles. These engines have greater power-to-weight ratios, about 5 lb/hp. If the vehicle is not knocked out after 5,000 miles, the old engine is thrown away and a new one installed.

Kits, which have one part number, may contain many small parts that normally go together. If only one part is needed, the kit is ordered, the one part is taken out, and the others thrown away.

Fuel economy is the most important consideration (after performance) in new engines. Quality or type of fuel is not very important. Under war conditions, a gallon of fuel delivered to point of consumption costs between $1 and $2, most of which is in transportation. Thus, an extra mile per gallon is a great saving.

### MULTI-FUEL ENGINES

The Ordnance Tank Automotive Command (OTAC) would like engines that can use local fuel, for example in the Near East, and is investigating multi-fuel engines. Only engines now capable of using many fuels are large diesels and gas turbines. Large diesels, for tanks, are being designed for multi-fuels. At the moment, multi-fuel engines are required only by the military; therefore, there is no coordination with civilian work.

Wherever possible, OTAC uses already developed equipment, and modifies other equipment for Army use. Attempt is also made to use the same component in a number of different applications. Development of synthetic materials for tires is underway, as are methods to protect rubber from zone deterioration. Other branches of the service are discouraged from developing new special vehicles where a standard model can be modified.

What would Army Ordnance like from civilian suppliers? Frankford Arsenal reports: greater use of miniaturized and transistorized components; greater use of light metals and plastics (fire control chassis, for example); maximum use of systems where human element is removed; improved reliability of miniaturized switches and low-voltage d-c relays.

## Cemented Oxide Points to Revolution in Machine Tool Design

DETROIT—Development of cemented oxide (ceramic) tools promises a revolution in machine tool design comparable to the one brought about by cemented carbides.

Speeds of 18,000 surface fpm were used at a demonstration by General Electric's Metallurgical Products Dept. to machine 1 10 in. from a bar of 1045 steel 13 in. in dia and 48 in. long. At a feed rate of 0.010 in. per revolution, machining was completed in one pass in less than a minute.

The operation was performed on a specially designed 20-in. lathe built by Leblond and equipped with a 150-hp direct-drive variable-speed motor. Special bearings both in the head and tail stock were equipped with thermostatically controlled forced lubrication.

Ceramic tools were held in mechanical tool holders, making replacement easier than with brazed tools.

### MACHINING RR AXLES

Also shown was the use of heavy-duty cemented carbide tools to machine a standard railroad axle. Speed was 150 surface fpm as compared with 30 fpm, best speed for high speed tools.

In another demonstration, rough and semifinish grinding were replaced by turning with a cemented carbide tool. Finish was about 25 microinches in grinding, compared with 15 microinches in turning.

Each of the new processes results in higher productivity, making possible a reduction not only in labor time required, but also in the number of machines required to perform a given amount of work. This in turn lowers investment and gives more efficient utilization of floor space.

## Expand Canaveral Test

WASHINGTON—The fast pace of missile firings scheduled in the months ahead is forcing the Department of Defense to expand the Cape Canaveral test center. The firing schedule includes some IRBM's—the Air Force Thor, Army Jupiter, and Navy Polaris; the Atlas and Titan ICBM's, both the Navy and Army satellite shoots, and a host of smaller missiles.

The center is building four big Titan launching pads and adding additional radar picket ships downrange to aid in tracking the missiles. Further expansion may come as the missile shoots are stepped up.

The shift to missiles has also caused the Pentagon to order the construction of a new multimillion-dollar missile test range on the West Coast. Dubbed the National Pacific Missile Range, the base will take five years to complete, but will start limited firings by the end of this year.

To be operated by the Navy, the range will be built around Navy's present missile center at Point Mugu, Calif. A net of tracking stations, both island-based and on ships, will be established along the same lines as those used by Canaveral.

# Central Control Shaping Up for Military R & D

WASHINGTON—One feature of Pres. Eisenhower's controversial military reorganization plan stands an odds-on chance of being put into effect soon: the proposal to centralize control of research and development projects under a new official to be called "director of defense research and engineering." (See chart).

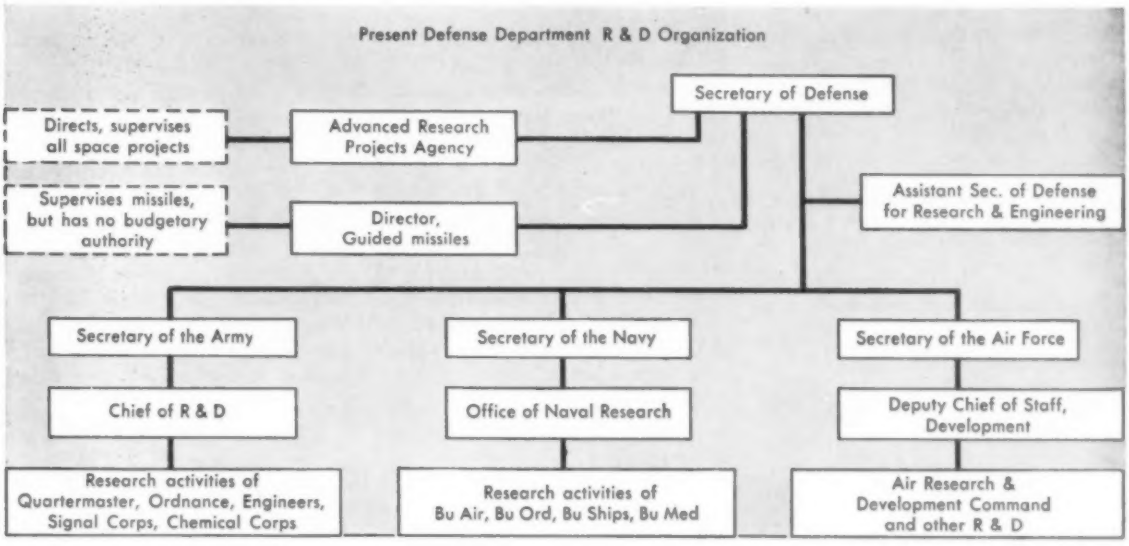
This director would, in effect, become a weapons development "czar" with powers to directly supervise—not merely coordinate—military R & D projects. On all R & D matters, he would report only to the Secty. of Defense. Excluding the three service secretaries from R & D responsibility.

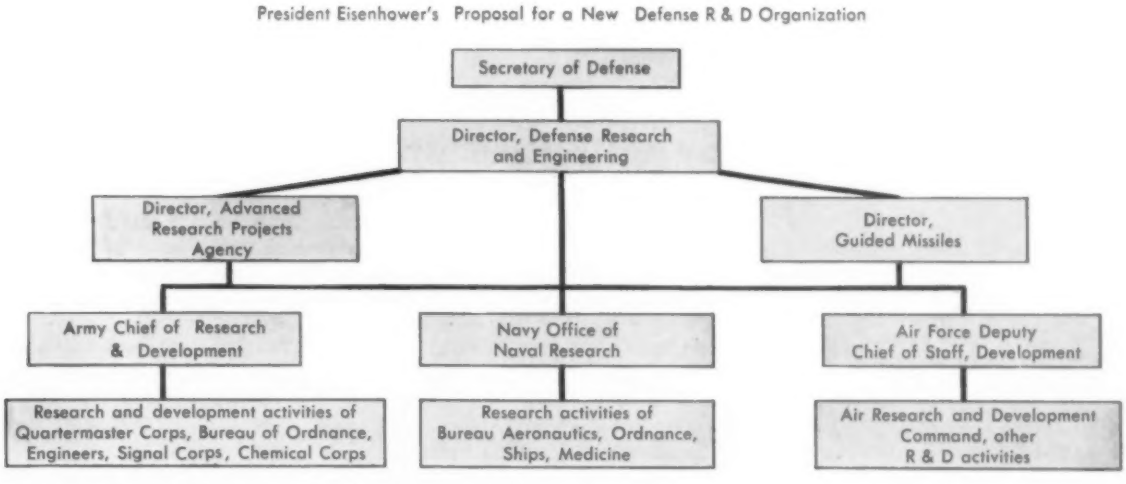
To stress the director's supervisory powers, he would outrank the seven assistant defense secretaries who coordinate procurement, construction, budgets and such. The position of Asst. Defense Secty. for research and engineering—now held by Dr. Paul D. Foote—would be abolished. Foote is limited to coordinating and general policy-making, has no direct operating functions, has authority only in nonmissile and nonspace fields.

The new director would also be given authority over military space projects (now run independently by Advanced Research Projects Agency) and missile projects (now supervised by Defense Dept.'s director of guided missiles, William Holaday.)

In effect, the new director would have the same type of wide-ranging authority over all military R & D work that Advanced Research Projects Agency now has only over space projects. This includes authority to award contracts directly, to farm out to existing military agencies administrative functions over R & D projects, to plan R & D objectives, etc.

R & D contractors would no doubt continue to deal on housekeeping matters with Air Research & Development Command, Office of Naval Research, the Army's Ballistic Missile Agency, etc. But the individual Services would not make big decisions on contractor selection.


Present Defense Department R & D Organization
Secretary of Defense
Directs, supervises all space projects
Advanced Research Projects Agency
Supervises missiles, but has no budgetary authority
Director, Guided missiles
Assistant Sec. of Defense for Research & Engineering
Secretary of the Army
Secretary of the Navy
Secretary of the Air Force
Chief of R & D
Office of Naval Research
Deputy Chief of Staff, Development
Research activities of Quartermaster, Ordnance, Engineers, Signal Corps, Chemical Corps
Research activities of Bu Air, Bu Ord, Bu Ships, Bu Med
Air Research & Development Command and other R & D


President Eisenhower's Proposal for a New Defense R & D Organization
Secretary of Defense
Director, Defense Research and Engineering
Director, Advanced Research Projects Agency
Director, Guided Missiles
Army Chief of Research & Development
Navy Office of Naval Research
Air Force Deputy Chief of Staff, Development
Research and development activities of Quartermaster Corps, Bureau of Ordnance, Engineers, Signal Corps, Chemical Corps
Research activities of Bureau Aeronautics, Ordnance, Ships, Medicine
Air Research and Development Command, other R & D activities

# Boston University Prof. Suggests 'Farming Out' of Engineers to Minor League Firms

BOSTON—The farming out by major industrial companies of young, promising engineers to subcontracting and/or smaller companies (as major league baseball clubs farm out young players to the minor leagues) has distinct possibilities. This is the opinion of John N. Flynn, Boston Univ. assistant professor and director of student personnel services with the College of Industrial Technology.

Prof. Flynn asserts that an industrial farm system would permit a step-by-step advancement in scientific maturity, as well as provide continuous information on an individual's research and laboratory capabilities.

He concedes that the obvious shortcoming in America's science lag is the shortage of trained personnel. However, he suggests that this is only one side of the coin.

"For universities to train more young talent is quite a different problem than how to best use the science talent that is currently being produced," he says.

### QUALITY, NOT QUANTITY

"The answer to our lack of trained scientific minds is not really how to push more young men through college, but rather how to properly pull results from the many talents we have already available to our national economy."

American industry, he maintains, should emphasize better methods of recruiting new engineers and scientists, as well as reducing the current high turnover rate of those who are employed.

"Too often," he states, "the man assigned to recruit engineers is one who has failed in the laboratory or in the field as an active engineer."

Industry spends approximately $2,500 in recruitment costs for every engineer employed, he estimates, plus additional thousands of dollars for initial training periods designed to acquaint the employee with his new organization and its research projects.

"Knowing these facts, it is logical to assume companies would make sure they were getting the right men," says Prof. Flynn. "But they do not get the right men and it is in the recruiting stages that immediate corrective steps must be taken so that our governmental and private laboratories can obtain and retain the best talents."

The B. U. personnel authority and engineering consultant has found that many company "campus representatives" actually know so little about their own organization that prospective employees are discouraged and given a false impression.

"What the applicant needs to know about his potential employer he generally does not find out from the company representative," affirms Prof. Flynn. "Many of these campus recruiters lack knowledge on company scientific policy and engineering know-how."

Even at the firm's home office, adds Mr. Flynn, "these persons responsible for hiring young men lack a knowledge of human relations. . . .

"Better group dynamics are needed when a young scientist or engineer comes to the home office. Unfortunately, too much emphasis is placed on the outcome of aptitude and general proficiency testing. The personality and scientific creativity of individuals seem to come last. . ."

He states that four important qualities for a young scientist or engineer cannot be revealed by testing: his creativeness, flexibility, specific knowledge in highly defined areas and ability to work under laboratory pressures.

"With too many industries relying on improper testing devices at the main office and placing too much confidence in questionable campus interviewing techniques, the final selection is often of little value.

"Once a man is employed, too much of his development is left to chance, Companies tend to neglect the fact that the successful utilization of an engineering talent is dependent on what happens to the man when he gets on the job. . . .

"We burden our best brains with routine tasks. Personnel departments and line staff managers must attempt to define the roles and scopes of operation for the inexperienced but aggressive young man, as well as the scientist who has proved his ability.

"Although it is always encouraging to have elder scientists working with younger men, too many firms curtail experimental progress with time-consuming instruction and orientation."

## A Clear View Through the Foggy-Foggy Dew

NEW YORK—Visibility in fog, haze and smoke can be improved by application of a polarizing technique developed at New York University's College of Engineering for the Air Force.

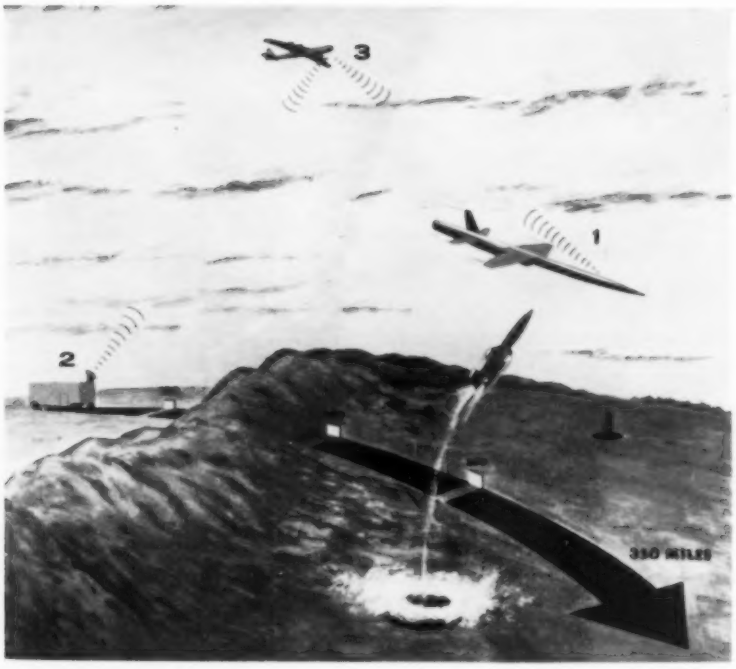
Basis of the development lies in optical properties of polarized light. When passed through a glass or plastic polarizing filter, light will vibrate in one direction only. Once polarized, the rays can pass through a second polarizing filter only if the light's vibration is parallel to the second polarizer.

By using a pair of polarizing filters oriented to pass light rays that are at right angles to each other, NYU engineers have evolved a technique for screening out light that bounces back to an observer from water drops.

One polarizer is placed over the light source, the other in front of the observer. Solid objects in the path of the light beam will depolarize the light, and when reflected, the light becomes visible to the observer. Water droplets will not depolarize light, and the rays they bounce back are not visible.

The observer must have particular geometrical orientation to the light source. He must be close to it looking along its beam. Or he may be located anywhere within either of two planes at right angles to each other whose intersection lies on the axis of the light beam.

The technique has potential applications for pilots making landings in fog, for navigators in crowded harbors where radar is relatively ineffective, and for automobile drivers.




**Tests for US air defenses . . .**
are carried out with Sperry Gyroscope's microwave command guidance system. A supersonic missile target (1) is intercepted by a ground-to-air missile. The target is controlled by van (2) several hundred miles away and aircraft (3) that relays microwave signals from van to attacking missile. Aircraft can also control drone on its own. The van is air-transportable to facilitate tests of defenses anywhere.

## Only 1 of 8 University Candidates Has 4 Years of Math

ANN ARBOR, MICH.—Out of every 100 students now enrolled in high schools accredited by the Univ. of Michigan. . . .

38 are currently studying algebra, geometry, trigonometry or advanced mathematics

17 are taking shop mathematics, business arithmetic, or other applied mathematics courses

45 are now studying general science, biology, chemistry or physics BUT . . .

Although well over 90% of this year's graduates from the schools will have at least one year of both science and math credit, only one in every eight grads will have completed four years of math by commencement this June.

These findings are based on a statewide survey of 600 U-M accredited high schools, with a total enrollment of 340,000 students. About 55,000 of these students will graduate this year.

Seven out of every 10 high school mathematics teachers in the accredited schools have had 20 semester hours or more of preparation in college mathematics courses. An additional two out of every 10 have between 10 and 20 semester hours of college math. Only one math teacher of more than 1800 had no math in college.

Approximately two-thirds of the 2,500 science teachers in accredited schools have had 20 semester hours or more of college science. Only one in five had less than 10 semester hours of college science.

About 80% of public and nonpublic Michigan high schools are accredited by the Univ. of Michigan. Accreditation entitles graduates of the school with a or "B" average to register at the university without taking entrance examinations. A recommendation by the principal and placement tests are required, however. In addition, each of the schools at the university has special requirements that new students must meet.

# Bits and Pieces

**The number of BS degrees in Engineering** in 1957 (31,211) fell short of estimates (34,000), but exceeded the 1956 figure (26,306). Total enrollment in September for all engineering students, exclusive of graduate students, reached an all-time high of 268,761. . . . Undersecretary of the Air Force, Malcolm MacIntyre, said that missile expenditures will rise to $2.8 billion in 1961, while procurement for manned aircraft will drop to less than $2-billion for the same period. He also said industries now considered secondary sources of airpower hardware (electronics, propulsion) may be prime contractors. . . .

**Boeing Airplane Co., Seattle, says that it plans to use new ramjet engines** which have been tested at mach 4 speeds and altitudes of 100,000 ft. The engines will power the advanced IM-99B Bomarc missile being developed for the Air Force. . . . McLouth Steel has installed the first plant in the US to make steel by the pure oxygen process. The plant is now being expanded, and other companies are getting into the field. . . .

**Over-all production and sales of die castings** fell off in 1957, but still had its third best year, exceeded only by 1955 and 1956. Aluminum die castings increased to 376.5-million lb., 2.5% above the record 1956 level. Zinc consumption for die castings was 703-million lb., which is 3.1% below 1956 figure. Uncertainty as to future zinc price stability because of the industry's demand for higher tariffs is said to have hampered development of new zinc die castings applications. . . . The Seattle Div. of Boeing Airplane Co. says that it was able to save $206,000 in blueprinting costs last year by using half-size prints. Besides saving material, the small size prints fit into one-quarter the space in cabinets and drawers. . . . 55 Governments and nine United Nation agencies have so far accepted invitations to participate in the second UN International Conference on the Peaceful Uses of Atomic Energy to be held in Geneva, Sept. 1-13. . . .

# READER TO EDITOR

## "A Rose by Any Other Name . . ."

*To the Editor:*

I am shocked and disillusioned, and at a complete loss for other adjectives to describe my reaction to the use of "exotic" in "Exotic Metals Seek Employment" (March 17, p. 66). Surely you know better! Even an associate editor should know better! And Webster is such an inexpensive and handy reference.

The Madison Avenue influence on our language is not now confined solely to the United States, so perhaps it is not surprising that advertising-ese has crept a few blocks across Manhattan. Those of us who struggle as technical editors to preserve certain standards in word usage and particularly precision of word meaning are greatly dismayed to run across example like this in a leading journal. Several of my "clients" would feel that pointing to this use of "exotic" in a McGraw-Hill magazine was all the justification needed for all kinds of magazines.

Do you really approve of this use of the word, or is it just another of those things that slip by in the first copy and the galley proofs only to hit one over the head in the printed copy?

—John M. Taylor, Jr.
*Office of Naval Research*
*Orlando, Fla.*

• "Exotic" here is like the term "rare earths," for materials which are no longer rare. It is a convenient though incorrect term. Are there any alternate suggestions? —Ed.

## Circular Route to Nowhere

*To the Editor:*

I've always admired your choice of subject, word and to-the-point comments. In your March 17 Tangents you came close to the heart of the cause of depressions: buyers' distrust. Man can be born dumb, but it takes positive effort to act stupidly.

We accept what's handed us for our efforts, or our taxes, as long as we believe we're getting more than we are paying. We accept lies, gypping, insults to our intelligence (?); we condone theft and other dishonesty in government from local to Federal level. We elect and re-elect dishonest people because we haven't any choice. We condone effects of self interest as long as it only hurts our brother.

Let them grab our money or freedoms—as long as they don't add insult to injury: THEN we fight back—by sitting tight.

We believe in people and their promises. We take for granted, though distrustfully, that what's printed is true, regardless of source. We accept at face value the advertising, publicity, the trial balloons, against our subconscious judgment (experience?).

But let us wake up some fine morning to find out that we individually cannot afford what we were led to believe was our right, our need, our social obligations; that we have to buy for cash or expensive credit—and we realize with a shock that we cannot afford to maintain our equity in this "living standard." Then we consider ourselves cheated, discriminated against, deprived of inalienable rights —without recourse, helpless, insecure. Then we act, passively; We sit tight and await developments; we don't buy. Then we don't have jobs.

Production may then be down. But services and obligations, such as governments, bonded debts, and public debt remain to be paid. With production down, maintenance and overhead remain at nearly the same level. The vicious cycle is with us again.

We're told a tax reduction will help. In addition, we're being tided over the rough spot by all kinds of handouts, all tax-supported. But there is no increase in productive work. This means higher taxes over-all, because of a drop in excises based on turnover and taxes based on income from production. Higher percentage of taxation can be hidden for the moment by increasing the debt limit. Public debt at Federal level must be written off by inflating the currency; it couldn't be paid off any other way.

We've lost trust in people's integrity. The things we have bought on their promise aren't practical. We were told we needed an oversize bus to drive to work and also to take the neighborhood for a trip: sociability and prestige. But we haven't the space to use it as we would: narrow roads, traffic jams, parking spaces. We can't drive far on trips; gas costs too much. The car is put together sloppily. So it's dangerous mechanically if we don't spend money and time keeping it repaired. It's difficult to drive in heavy traffic; curved glass distorts vision. Light-colored interiors and chrome make the inside too bright for safe night vision, make driving a strain from reflected glare in daylight too. In short: we don't get what we paid for.

Add to this 36 months to pay, 20 years of home mortgage, taxes, high insurance rates. Add defense obsolescence, and staggering outer-space and missile costs, cold-war psychology, and performance failures well advertised—and look at the tax future.

We feel we are being sold a bill of goods, and are stupid in our inertia—we just sit tight: stop-look-listen.

To get us going again will take a renewed belief in the integrity of people, government, companies. For years the press kept us so excited with on-and-off crises that we didn't analyze conditions leading to our condition.

We realize that as individuals, we are helpless. We can only try to hang on to what we own now, until somebody makes us believe again in honesty and integrity, and thus restores our belief in our value as individuals.

This passiveness is our only defense, since the exercise of our voting right and duty has left us with a top-heavy, seemingly defensive public service of sometimes doubtful honesty as far as our personal good is concerned. The next logical development might be a voters'-strike boycott of the polls.

Better communications and belief in our ability brought us a high standard of living. Our loss of integrity is breaking it down.

—Frederick S. Bloch
*Milford, Conn.*

• Mr. Bloch is an expert in deep-hole drilling and makes equipment for this work. —Ed.

## Correction

In transcribing numbers from testimony on salt-water conversion (*PE*—Apr. 7, '58, p. 9), errors were made in quoted prices. The cost on the Badger method is 50 cents per 1000 gal., rather than per gallon as quoted; and that for the Maxim unit is 63 cents per 1000 gal. rather than 68 cents per gallon, as quoted.

Panel discusses putting product into production to open . . .

# Third DESIGN CONFERENCE and SHOW

**Here is a session-by-session and booth-by-booth study of the new ideas in Chicago, April 14-17. If you were among the largest attendance to date, here are your notes; if not, here's what the editors considered most worthy of note—including many brand-new items "under the counter" in dozens of booths.**

CHICAGO — Recession-stimulated competition in materials, processes and components is paying handsome dividends to the design engineer, in the opinion of many attending the Third Design Conference and Show at the Stockyards Amphitheatre here April 14 to 17. The designer is demanding — and getting — better performance, higher quality, and even lower costs on the elements he puts in his product, whether it be a capital-goods or a consumer item.

Attendance at the Show was about 17,000, at the Conference sessions about 1000. The latter figure is off about 700 from that of last-year's Conference in New York. Some 411 exhibitors used 125,000 net sq ft of exhibit space, showing about 12,000 products. An interesting development this year was the number of new products that were not being displayed openly. They were held half under wraps, like high cards in a poker game, and shown only to important potential customers, and were not announced before the Show as so many were (PE—Mar 31, p. 131 to 168). Nine *Product Engineering* editors combed the Show and attended Conference sessions, contributing, each in his specialty, to the report which follows.

Not included are the individual papers, which were abstracted prior to the Conference (PE—Mar 31, Part II, p. 4 to 7), but the panel session and annual luncheon speaker are.

## "Creativeness . . .

. . . is the essential ingredient in your work. . . . Scientific research has brought untold numbers of new products into being; it has created entire new industries; it has multiplied and expanded our material achievements to an extent undreamed of only a few decades ago. And in utilizing the benefit of scientific research and development, this nation in its abundance has attained the most nearly classless society ever known."

Thus Dr John T. Rettaliata, president of Illinois Institute of Technology, opened his address at the luncheon on Tuesday. He went on to point out that we must in the future achieve a greater economy even though our natural resources for that economy are diminishing rapidly. This requires greater emphasis on fundamental research. Some 90% of our present research is of the applied type—which jeopardizes the future by "depleting our stockpile of existing

knowledge. **We have been living off the fat of prior discovery** . . . Replenishment can be accomplished only through fundamental research. Yet, only 10% of our research effort is devoted to this vitally important work.

"**We have not been successful** . . . in this country in generating sufficient appreciation of the value of scientific research to an extent that we do something about it. We have . . . had to call upon foreign scientists, trained in a European atmosphere of basic-research emphasis, to play a major role in some of our scientific developments."

Dr. Rettaliata suggested that the bachelor's degree will soon be superseded by a graduate degree as the minimum requirement in engineering, as has already occurred in the sciences. He also suggested, as have other educators, that more women should be encouraged to enter engineering. Currently only 1.25% of the profession are women—less than in law, teaching, journalism, or medicine. Only 0.5% of engineering students are women.

On creativity, his basic subject, Dr. Rettaliata summarized: "The creative man is not bound by preconceived ideas. Consequently, **some of the results of his work may appear too radical for acceptance. These should not be brushed aside without careful and objective evaluation, however, for history reveals that yesterday's heresy frequently becomes tomorrow's orthodoxy.**

"As we approach the area of diminishing returns in the effectiveness of existing procedures and processes, the thinker becomes increasingly important. More than ever before, creativeness will be called upon to extend the boundaries of ability, to solve the unsolvable, to achieve the unattainable.

"**Since the individual is a vital link** . . . to the dynamic society within our reach, he should be cultivated, encouraged, and permitted to work in an intellectual climate. He should be given the incentive to excel.

"If we as a nation are to attain the stature of which we are capable we may have to improve our methods of rewarding the creative impulse. Individuals and organizations are most productive when there is a stimulus to research and invention.

"We should make the most effective use of the gifted individual. Since **there is no substitute for genius,** more emphasis on incentives to encourage those who have the ability for advanced thinking and proper recognition of their creative efforts are needed. **Creativeness is the key to industrial progress.**"

## STANDARDIZATION CUTS COSTS, IMPROVES QUALITY . . .

. . . and puts the design into production faster said panel members at the opening session, April 14.

H. Walter Regensburger, chief engineer, General Engineering Dept., Link-Belt Company, stated "that on high-production items standardization is a must."

Leo Kevitt, manager of manufacturing, Instrument & Alemite Division, Stewart Warner Corp., reported the use of common parts lists for the Design of high-production products.

Joseph Manuele, director, Headquarters Quality Control, Westinghouse Electric Corp., cited a study that showed 1300 different hole sizes had been specified between 1/16 and 1 in. before standardization.

Donald Harwood, vice president—Purchases, Fairbanks, Morse & Company, said "that standards tend to reduce inventory, increase part availability and improves purchasing."

All indicated that standards sheets on purchased or specified items must be available to the engineering department.

### Appearance . . .

. . . is a factor even in the sale and acceptance of industrial equipment. Faith in the engineering design is common among industrial equipment buyers. "Design is rarely questioned" says Regensburger, "but product appearance and styling have killed sales even after market research has proven the product's need". Other panel members indicated that can openers, cars, and other consumer products are not the only items needing styling. Gear reducers, heavy plant equipment, and even hidden items such as automotive pumps and filters, were cited as examples of parts that require eye-appeal to the industrial buyer. Appearance is an important consideration in the mockup, pilot model, and manufacturing stages of the product development.

### Sub-contract verification . . .

. . . is never accepted. "All items," according to Manuele, "must be quality tested, checked and approved by the prime contractor's inspection department. Best method is to examine the vendor claim in your own laboratory", he continued. "If equipment for inspection is lacking, an independent testing lab should be used, or personnel can be sent to the vendor plant".

### Communication . . .

. . . between vendor and Engineering can be handled directly or through Purchasing. "In all cases," Harwood said, "Purchasing places the order". Engineers can request price information and go into the field to inspect vendor goods or materials. At his company, said Kevitt, "an engineering buyer is stationed in the engineering department but reports to the purchasing agent".

### Discrepancies . . .

. . . in the specification of the purchased product can be handled by committee. Quality Control calls a meeting with Engineering, Sales, Manufacturing and Inspection and presents the data collected on the discrepancy. Manuele, in outlining the system, pointed out "all groups must attest to the changed document after the decision is reached and the changes made". The same system, other panel members stated, could be used on changes made between the pilot and the production model.

### Certified prints . . .

. . . are an unnecessary expense. "Purchase order is all the legal restraint needed between a vendor and contractor" both Manuele and Harwood agreed. Manuele also explained that "sampling—a statistical method of sampling—is legally valid and part lots can be rejected on this basis". An appeal, however, can be made and there are cases on record where specifications have been loosened to accept the lot. Again, all interested groups must attest to the changed specification.

**Choice . . .**

. . . of buying or making a part rests primarily with Purchasing. "Major factor is ability of own shop to produce and the volume of work in production", says Harwood. "In a slack period one uses his own facilities, even though part may cost more since overhead is still present". Surplus of labor colors the decision.

**Mockups . . .**

. . . can be handled in a variety of ways. Regensburger mentioned that "big machines and heavy equipment almost always have to be field tested". "Sub-assemblies and smaller units can be lab tested prior to assembly", Kevitt cited. Other members of the panel mentioned that some units lend themselves to simulated field-condition testing in the laboratory. Many units are field tested for years before they are marketed.

**New tooling . . .**

. . . or process equipment is made on the basis of market potential. "Purchasing enters the picture usually at the time of purchase", says Harwood. "Manufacturing makes the decision to buy but Engineering is not dictated to on process or fabrication method or procedure on high-production items", Manuele concluded. All agreed that economics plays a large part in the decision to add new production processes.

## FASTENINGS SHOW CHANGES

High-strength bolt to replace rivet had a length of the shank under the head with a spiral knurl forming an interference fit in a standard clearance hole. With a moderate hammer blow, the bolt becomes captive, and can then be drawn down to seated position by a nut without holding the head. Material is 1038 steel, heat treated per ASTM A-325. Construction is available in sizes from 5/16- to 1-in. dia, from Lamson & Sessions Co.

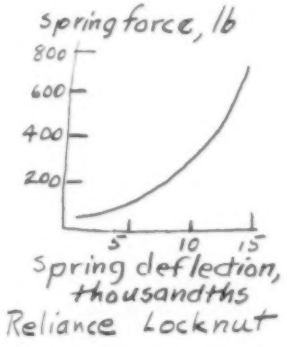
Form of the knurled tooth is key to the effectiveness of the design. Shank is knurled twice: first, a spiral knurl forms teeth that are rounded on the entering side and square on the side toward the head; a lateral knurl breaks these up into separate file-like teeth. No chips are formed in driving the shank on, but shank fits tight enough to prevent rotation when the nut is being drawn tight.

**Integral flange . . .**

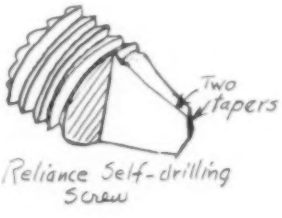
. . . on a cold-headed nut, developed by MacLean-Fogg, has a thread-locking function obtained by deforming the top two threads. Since the flange permits the nut to go on only one way, this method of thread locking gives no trouble in assembly. Integral flange saves the cost and handling of a separate washer.

**Hex lock nut . . .**

. . . for No 6, 8 and 10 screws, offered by Reliance Division of Eaton Manufacturing Co., is a one-piece unit that provides an exceptional range of spring action. Spring member is an integral radially split Belleville washer under the nut. Washer provides 0.015-in. deflection before seating, and develops sufficient force to break the screw if driven solid—for the No. 10 screw spring develops 700- to 800-lb tension.




Another innovation displayed by Reliance was a self-drilling, self-tapping screw. Inserted in a standard nut-running tool, and with considerable pressure, of course, a double-tapered end on the screw drills the tap hole and cuts the thread—in plastic, aluminum or steel. The tap hole is drilled, threaded, and the screw driven home all in one operation. Screw material is 1022 steel case hardened.




**Thread-locking blind fastening . . .**

. . . for 10-32 and ¼-28 threads, developed by B. F. Goodrich Aviation Products Division, has serrations under the head to give resistance to turning equal to key construction but without special drilling. Distorted threads for the outer ¼ of the thread length develop locking forces meeting MIL-N-25027. For minimum weight, these Rivnuts are made of 4037 steel; lengths are currently available for panel thicknesses from 0.035 to 0.335 in.

Another new Rivnut design, based on some undisclosed developments in cold heading, has cut 40% from the cost of larger sizes. Largest size currently available is for ½-in. bolts; materials are aluminum or steel with flat or countersunk heads.

**Wood screw and stud combined . . .**

. . . cuts assembly costs for components mounted on wood or plastic panels. This new screw, just announced by Shakeproof, has a left-hand wood screw and locking nibs on the underside of the head; machine-screw threads on the stud are standard. A special point on the stud helps to find the nut and bring it into alignment

to prevent cross threading and permit blind applications. The two threads are rolled in separate operations, and length of each thread can be varied as needed. Available in all standard heads and screw sizes.

**Four new items . . .**

. . . were displayed by Greis Reproducer Corp: an insulated-head screw with the screw molded as an insert in a hex head of nylon; a flanged hex nut in No. 4 size; molded nylon ma-

chine screws with recessed head in a full range of sizes from No. 4 to ¼ in.; and a round head tamper-proof nut die cast in the ¼-13 size.

**Self-tapping thread inserts . . .** . . . are now available from Groov-Pin Corp. with a Nylok thread-locking insert. New design incorporates a truncated external thread which gives increased wall thickness. Thread-cutting element is a round hole just inside the tapered end rather than a slot open to the end. Made to MIL-MS-35914 in case-hardened and cadmium-plated steel with full-length internal threads to Class 2B or 3B specs.

**Sealed threaded ports . . .** . . . in light-weight hydraulic equipment are offered by Heli-Coil in a new design combining a stainless thread insert and an O-ring. Design takes standard fittings and provides non-seizing permanent threads while sealing against leakage through either the outside or the inside thread.

**Multiple tubing clip . . .** . . . for hydraulic, lubricating, air or instrument lines was shown by United-Carr Fastener Corp. Designed as a sheet-metal stamping, it snaps in place through two holes and holds lines under spring pressure. Sharp ends on spring fingers hold lines from axial movement in either direction. Currently available in one design for five parallel ⅝-in. lines; other items are planned as needs arise. Tool cost limits application to fairly high-production applications.

**Toothed-locking washer . . .** . . . integral with nut is relieved on underside to permit deflection of edge of washer for spring action under tightening force. Ratchet teeth formed under the washer face are angled on advancing side but square on the back side to resist loosening. When nut is torqued home, teeth become embedded, and require as much as 40% more torque to loosen. Designated as X-58 design, these locking nuts, made by Russell, Burdsall & Ward, are available in wide range of sizes in any head style except flat head, in any length from twice the diameter. Also supplied as a nut, carburized about 0.008 in. deep to withstand power wrenching.

**Plan Hold caddy rack unit** holds 1200 blueprints in accessible, portable rack.

## DRAFTING AND DRAWINGS

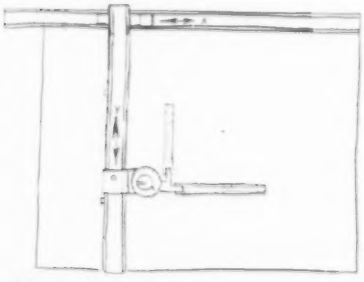
Drafting machines now enter a new phase. An x–y tracking unit has been equipped with a standard protractor head by two major manufacturers to add new flexibility.

This is the latest in the line of more and more complex equipment to help the draftsman-designer draw a straighter line. T-squares and parallel straightedges were challenged some years ago by the drafting machine, a complex gadget that needs no triangles and cuts drawing time by as much as half in some cases.

Then vertical boards made their appearance and proved invaluable for larger, more complicated asemblies and parts. To adapt the drafting machine to vertical boards, counterweights were added, and orderly rows of heavy weights are familiar sights in the more advanced drafting rooms.

But adjustable boards, that may be swung from vertical to horizontal positions at will, made a serious hazard of the counterweight. It swings through a large arc and is likely to injure the next man in line.

And so the Universal Drafting Machine Corp. and Keuffel & Esser Co. have both added x–y tracking units to their lines. These machines are fully counterbalanced for all positions and the drafting-machine head moves easily left and right or up and down over the entire surface of the board without protruding linkages or counterbalance weights.



**Universal Tracemaster** is a standard drafting-machine head mounted to permit motion in either x or y directions on counterbalanced belts.

Here's a run-down of what is available and the advantages and disadvantages of each for the specific type of drafting work involved:

**T-square and parallel straight-edges** require triangles, horizontal boards, longest time per drawing. They are tiring and inefficient despite lowest (by far) first cost.

**Standard drafting machines,** uncounterbalanced, are best for detailing (small drawings in large-volume production). They must be used on small, horizontal boards. No triangles are necessary. All current makes can be locked at 15° intervals and have baseline reset control.

**Counterbalanced drafting machines** have the additional virtue of application to vertical drafting boards. Larger drawings are made with ease and recent research indicates that the vertical position is much less tiring for the draftsman. This type of drafting machine may not be used horizontally without considerable sacrifice in space.

**X–y tracking units** are applicable to both horizontal and vertical boards without loss of space. Their second big advantage is that either track may be locked to permit drawing a single vertical or horizontal line for the full width or length of the board. This is invaluable for layout and assembly as well as design where points must be transferred from view to view.

**Drawing storage . . .** . . . is still a major problem, though some interesting solutions are beginning to appear. Recordak has redesigned its cameras to give exact

duplication of image density and resolution on film despite differences in the original drawings. This permits use of the automatic high-speed electrostatic or silver-emulsion enlargers coming on the market. Microfilm is still some four to five times more expensive to reproduce than standard blueprinting, but the savings in space (on filmed rolls or "aperture cards") can be staggering. Further, filing and withdrawing from file becomes a simple task and brief inspection is possible with one of the many viewers on the market.

However, blueprints will always be used in the shop or out in the field. Plan Hold Corp. has just announced a "caddy rack unit" designed to hold up to 1200 sheets—all readily available for detailed examination. The unit folds up for shipment and has wheels for easy transport from room to room.

### Mylar tracing material . . .

. . . has been announced almost simultaneously by both Ozalid and Keuffel & Esser. The material will take pencil, ink and typing and is easily and cleanly erased by soft-rubber erasers. Cost will be competitive with tracing cloth with the advantages of: complete indifference to water, extraordinary toughness (it cannot be torn by hand) and good dimensional stability.

## NEW MATERIALS

### Shell molding and sand casting . . .

. . . are teaming up more and more, with the more expensive shell process being used for intricate coring to save machining costs. Superior Steel & Malleable Castings Co., Benton Harbor, Mich., for example, cites increased use of this technique in valve bodies, fittings, and trailer-hitch castings.

### Pure copper castings . . .

. . . as a replacement for forged parts to cut cost are exciting moderate interest, according to Aurora Metals Co., Aurora, Ill. Developments in the coated-sand shell-mold process are making these parts easier to cast. Main problems are high conductivity and strength . . . the customer wants both in the same part. Be-Cu alloys continue to be used for top strength, but conductivity drops off sharply. Cr-Cu alloys for medium strength have higher conductivity. Efforts are being made to resolve this dilemma, so that more castings can hit the big electrical market . . . motor-brush holders, welding-rod holders, transformer breakers and the like.

### Stress-corrosion . . .

. . . is a headache in aluminum sand castings, but Alcoa may be coming up with a solution. The problem is susceptibility to stress-corrosion cracking after heat treating to the T4 temper. Alcoa has under development a new high-Mg alloy, tentatively designated X250, which will have special additives as an intergranular corrosion barrier to improve corrosion resistance considerably over that of the S220 alloy.

### Nylon gears . . .

. . . are still having tolerance problems caused by moisture absorption and mold shrinkage, but not many manufacturers are spending much development time on the new castor-oil-derived, low-moisture-absorption nylons recently developed abroad. Many are cutting down the nylon content by using metal hubs and wheels with the nylon teeth molded in place on the periphery. This also gives more control over shrinkage. Hubs are die-cast, stamped, and cast by powder metallurgy. Westplex Corp., Rochester, NY, even uses two-part powder-metal hubs, with the wheel of steel and the center hub of bronze pressed-in for a sleeve bearing.

### Printed-circuit adhesives . . .

. . . for bonding the copper to the phenolic laminate are being improved by Raybestos-Manhattan Corp, NYC. Under development is a neoprene-modified epoxy-phenolic adhesive that promises to improve bond strength for circuit boards where the copper is laid down by spray technique. Temperature performance looks like it may be in the 500 F range.

### Adhesives for cans . . .

. . . are under intensive development by the container manufacturers as a hedge against the possible choke-off of Asian tin supplies. Substantial sums are being spent on special equipment to test side-seaming techniques with presently available adhesives. Technical problems are formidable: adhesives must be applied easily, have enough tack to prevent springback before passing into the curing oven . . . all this at a rate of 600 cans per minute

### Zinc die-castings . . .

. . . assembled by adhesives as an alternative to complex cored castings, have interesting cost-reduction possibilities, according to Minnesota Mining & Manufacturing Co., Detroit, Mich. Typical example is a gasoline-pump housing bonded together from five die-cast parts. Parts manufacturers like Doehler-Jarvis Co., however, are relying primarily on improved mechanical fastening methods. Emphasis here over the last year has been on improved stud-spinning techniques. D-J is excited about adhesives in another area, though, addition of color and identification to zinc die-cast auto parts by adhesion of plastic-insert emblems. This twist has already been sold to one large auto firm, which reports the assemblies stand the necessary weathering tests and corrosion conditions met in road service. Plating methods have been improved too, says D-J, citing a new double nickel coating which has 30% better corrosion resistance than the conventional Cu-Ni-Cr coating. This one, too, has the automakers beaming . . . as long as nickel stays plentiful.

### White anodized aluminum . . .

. . . doesn't seem like news with all the brilliant hues available on aluminum by this process. Yet white has eluded the anodizing industry for years. Colonial Alloys Co. is displaying a coating which it says places white on the anodized color list. Also developed by Colonial is a bright-anodizing technique that does not require ultra-high-purity aluminum for a brilliant chrome-like depth to the color. This may be a boon to aluminum die-casters and extruders who want bright lustre, but don't like the adhesion characteristics of very-high-purity aluminum.

### Deep-drawn shapes . . .

. . . with tubing built-in are a new twist in the Roll-Bond process developed by Olin Mathieson Chemical Corp, East Alton, Ill. Roll-bonding, an intriguing way to build heat-transfer surfaces, involves silk-screening a tubing pattern on aluminum sheets, rolling the two together, and applying pressure to the unbonded interface to raise the tubing pattern. Parts like refrigerator cooling coils have been brake-formed from such sheet, but now the bonded sheets can be deep-drawn and the tubing expanded afterward. The process is being extended to copper and steel, too, although deep-drawing is, thus far, limited to aluminum shapes.

### Expanded metal has gone sophisticated . . .

. . . over the past year with the introduction of intricate patterns, according to Designers Metal Corp, Chicago, and Penn Metals Co., NYC. Coming a long way from waste baskets and machine guards, the new patterns are being applied where open area is needed in products like grilles for tractors, radios, and juke boxes. Colors are applied by spray painting or vinyl cladding, with pre-painted metals under investigation.

### Flame-sprayed tungsten-carbide . . .

. . . will be introduced soon by Kennametal Inc., Latrobe, Pa., to extend its line of hard-surfacing techniques beyond the presently developed weld-deposition method and the flexible, glass cloth-backed hexagonal wafers applied by silver soldering, brazing or pressure-sensitive adhesive to large areas where abrasion resistance is needed. New flame-spraying powders will be usable in standard flame-spraying equipment.

### Epoxy potting compounds . . .

. . . with improved thermal shock resistance are possible with a new silicone additive, Syl-Kem 90, developed by Dow-Corning Corp., Midland, Mich. A casting 1 in. dia by 1.5 in. long, containing a piece of $\frac{5}{8}$-in. hex steel bar, for example, will take repeated thermal cycling from 150 C to −55C without cracking. Impact strength with 40% Syl-Kem 90 added to Epon 828 doubles, though flexural strength drops somewhat.

### Low-cost fiberboard . . .

. . . is a coming product from the research labs of Spaulding Fibre Co., Tonawanda, N.Y. Main features of the new material, tentatively designated R-10, are good stiffness after forming and curing, and low moisture absorption. Also new in the fiber-based structural-materials area is a non-flammable vulcanized fiberboard developed by National Vulcanized Fibre Co., Wilmington, Del. Poor fire resistance has been a barrier to traditional vulcanized-fiber products, particularly in materials-handling equipment. The new board can be formed as readily as other grades.

### Tighter tolerances on phenolic laminate . . .

. . . parts and shapes are being demanded by the designer, according to Synthane Corp., Oaks, Pa., in line with the greater emphasis on equipment quality. This has required development of machinery by the laminate manufacturers, like the wet-sander worked out by Synthane to finish vanes for air motors, compressors, and pumps. Service temperature requirements are up, too, with the missile and aircraft industry's demands for laminates to take 600 F and above.

### Vacuum-shaped Dynel . . .

. . . is a new development of Union Carbide Chemical Co., uses standard thermoplastic sheet molding processes to form textured shapes for radio covers, ribbed battery separators, split flange covers. Filled with foam-in-place cores, shaped Dynel parts show potential for auto arm rests, crash pads, and seats. Other molding processes like matched metal die and plug molding using cheap dies of wood, plaster-of-paris, or papier-mache, are also feasible.

### Larger polyethylene molded parts . . .

. . . are becoming more common as the price of linear polyethylene drops steadily, according to Celanese Corp., NYC. Typical parts in the offing are auto heater ducts and crates for trucking bottled soft drinks.

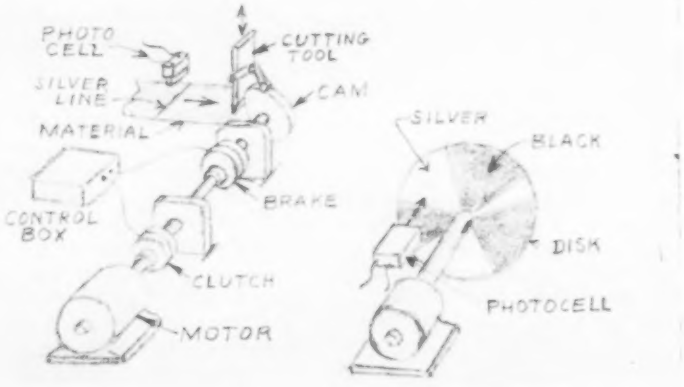
### Synthetic fiber reinforced plastics . . .

. . . which created quite a stir last year, are not panning out so well. In addition to high cost, compared to glass fibers, elongation is too great for good reinforcement, even though the bond between the synthetic fibers is excellent. Primary area of application is in parts requiring weather and chemical resistance.

## MECHANISMS MOVE ALONG

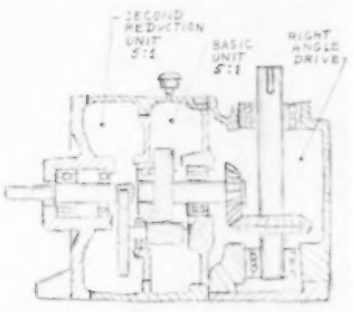
### Clutch and brake . . .

. . . combine with photocell (sketch) to produce high-speed indexing up to 100 cycles per sec, in a new unit by Warner Electric Brake & Clutch Co. Both clutch and brake use the stationary field principle which avoids need for slip rings and brushes. Material—such as steel to be cut to vari-



ous lengths—is fed under its own power and has scribed silver lines which reflect light back to the photocell. This triggers tubes in the control box which shift current from brake to clutch, thus actuating a cam to operate the cutting tool. Method is also successful in transferring data from magnetic tape to punched cards.

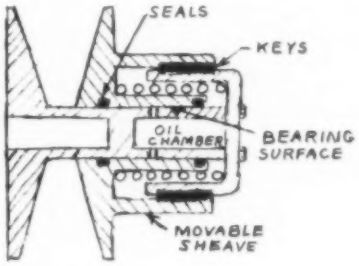
Repetitive-cycling operation is easily obtained from a disk and photocell combination (sketch) powered from a separate source. Clutch is activated when silvered segment is opposite photocell—brake operates when black segments show. Holes in disk can be used to pass light to photo cell from fixed source. Pattern is easily changed to suit operation program.




### Modular construction . . .

. . . has had a spectacular success in machine tools because of the need for specialized machines that can be knocked down and reassembled to do a new job when there is a product change. This trend is infiltrating the mechanical-component field, and special reducers can now be obtained which combine 16 separate modular sub-assemblies to produce over 1000 different models. Only a wrench is needed to change types.

Developed by Westinghouse Electric Corp., the basic unit (sketch) consists of a case and a 5:1 gear reduction set. To this can be added (1) other reduction sets—a second gives 25:1, a third gives 125:1, and a fourth gives 625:1; (2) right-angle drives, with the unit mounted for power takeoff from any direction by relocating the oil breather and level indicator, and by replacing the oil seals with face-type seals; (3) gearmotors, either bolted directly to the reduction units, or mounted on a common bed plate. Wall and ceiling mountings can be obtained by indexing all of the gear cages with respect to the gear case in 90 deg increments by using any one of four sets of dowel pin holes on front and rear of the case. Basic unit is available in seven sizes for ¾ to 30 hp.




### Resilient keys . . .

. . . in new spring-loaded, self-adjusting pulley developed by T. B. Wood's Sons Inc., prevent freezing and fretting corrosion of movable sheave (sketch). Keyways were moved radially outward to leave oiled bearing surface free of grooves. Oiled surface is lubricated by centrifugal-force feed from oil chamber. Resilient keys made of rubber coated with nylon pads further improved design by permitting a continuous angular oscillation, or dither, caused by load fluctuation from normal belt behavior. This assured uninterrupted lubrication between bearing surfaces. Horsepower ranges from 1.5 to 15.

### Whirling labyrinth . . .

. . . and fan-like ribs keep variable-speed eddy-current drive cool when operated at low speeds. Heat dissipation is the main problem with eddy-current drives because all slip losses resulting from difference between input and output speeds are converted to heat. New unit by Cone-Drive Gear Division of Michigan Tool Co. houses the rotating iron flux rings in aluminum housing which uses ribs to induce negative pressure around the rings. Labyrinth keeps air moving at constant speed symmetrically around all surfaces of housing. This gives constant heat distribution and avoids distortion and thermal stresses. Air Cooling is said to permit operation of 150-hp unit down to stalling point at full torque. Horsepower range from 10 to 150.

## POWER AND CONTROL

### Electrical power and control . . .

. . . product lines are well developed, but with few major changes in design concept. Motor manufacturers have been busy catching up with the NEMA (National Electrical Manufacturers Association) rerating program. Relays, switches, circuit breakers and solenoids are abundant, substantial, but fundamentally unchanged.

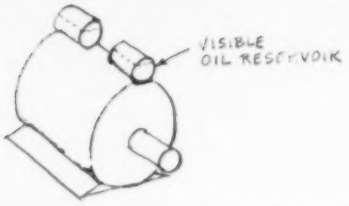
Some trends appear definite. Combination synchronous-induction motors are being added to motor product lines. Louis-Allis, for example, has introduced the "Synchro-spede." It operates as an ordinary squirrel-cage induction motor, accelerating until it almost reaches synchronous speed. Then it locks into step because special rotor bars and flux-guiding paths create fixed poles.

Encapsulated (impregnated) stator windings for service in corrosive atmospheres are offered by several companies. Allis-Chalmers already has epoxy-resin-covered windings for ratings up to about 15 hp and proposes to increase this soon. Above 75 hp, 1200 rpm, silicone insulation is provided. Advantage is ability of the encapsulated open-type motor to do the job of an enclosed motor.

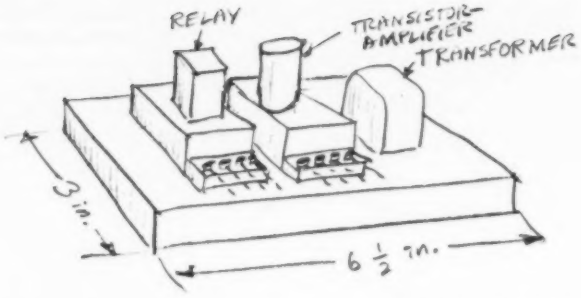
Small induction motors continue to challenge series-wound for business machines. Shaded-pole are still popular and low-cost, are for light duty; some makers are extending lines to higher ratings.

Wagner Electric Corporation believes that NEMA-frame motors up to 10 hp can be mounted directly to fan housings and to other assembled products, with resilient mountings. Industry has formerly been satisfied with 3 hp.

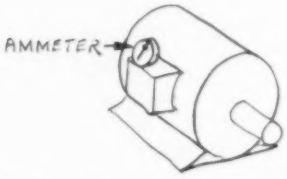
Homestead Valve, in conjunction with Flo-Torq Corporation, introduced a cylinder-operated plug-valve line. A pinion on the plug-valve stem axis mates with racks machined on a pair of balanced pinions (moving in opposite directions). The result is a powerful, controlled turning action. Assembly is relatively leakproof and operates from fluid or gas pressure.




Franklin Electric Co. has designed a motor-lubricating system with visible reservoir above each sleeve bearing. Although not in commercial production, it will deliver desired flow of oil to match any customer requirement. Reservoir size is determined by years between scheduled overhauls of other customer equipment.

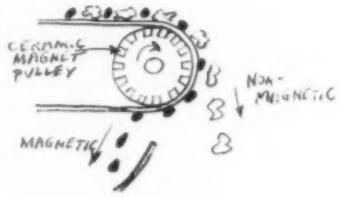


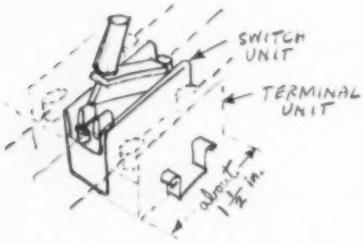

Cutler-Hammer showed a transistorized relay assembly that accepts microamp signals and switches watts of power. A small power-supply transformer lowers supply voltage, the plug-in transistor-amplifier cell triggers a Potter & Brumfield miniature relay, used in the assembly and the relay contacts deliver 155 volt 60 cycle a-c to the load.




Marathon Electric Mfg. Co. offers an induction motor that utilizes built-in current transformer and ammeter to give indication of load being carried. Sold mostly for pumping, its ammeter is calibrated in flow units. Variations in pump and motor performance probably affect accuracy of reading, but method seems simpler than installing flowmeters.

Indiana Steel Products Co. reports increasing interest in ceramic-magnet materials. For example, Stearns Magnetic Products Co. now offers Indox V in place of electromagnets for magnetized pulleys. Equal pulling power is claimed, without wiring, heat or moisture problems. One axial bar is north, next south, and so forth.



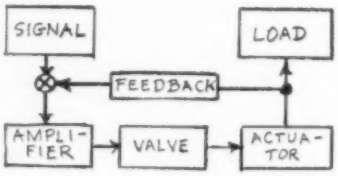




Marathon also exhibited individual switch units that fit next to two-terminal blocks in the "Building-block" terminal strip channel. Any number can be stacked along the strip at any point, and they take no more space than plain terminals.

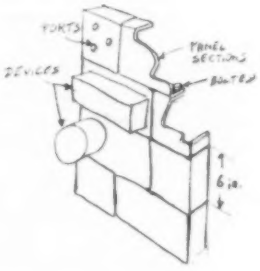
Zenith Electric Co. now offers a ganged adjustable timing panel. Clock-type timers (15 suggested, more possible) are geared together and driven by a synchronous motor. Each timer face has closely spaced tabs around the edge, set to open or close the circuit as the mechanism turns.

## Fluid power and control . . .

. . . show no rush to high pressure and temperature. Some 5000-psi control valves were displayed, but 1000 to 1500 psi was the usual limit. Aircraft components, modified for commercial applications, are common. Electric, pneumatic and hydraulic controls are all getting increased attention.




Vickers Inc., Machinery Hydraulics Div., attracted servo enthusiasts all week to a electro-hydraulic-control test stand. Prime performer was a new electro-hydraulic servo valve, but other test equipment completed a typical "control loop" so simply that low IQ was no bar to one's understanding. Servo accepts milliamps of signal current (from potentiometer or synchro feedback), has output up to 18 gpm with 3000-psi supply pressure. First stage of 2-spool design is a pilot positioned by permanent-magnet differential-torque motor. Output stage throttles oil flow linearly with differential current, and has adjustable feedback linkage to pilot. It is designed for low-frequency response up to 100 cps because most industrial applications do not exceed this range.




Birmingham Hydraulics, Inc., has developed device-mounting plates called "Pan-secs" that bolt together in 6-in. sections to form vertical panels looking like switchboards. The control hardware is mounted on the front, tubing on the back. Another manifolding method consists of drilled rectangular blocks of metal. These serve to mount hydraulic devices and are used as sections in the panel.

DU PONT
REG. U.S. PAT. OFF.
Better Things for Better Living . . . through Chemistry

PRODUCT ENGINEERING NEWS
LATEST PROPERTY AND APPLICATION DATA ON
LUCITE®

# Traversing window covering of LUCITE® filters sunlight . . . provides ventilation

Beautifully molded of Du Pont LUCITE acrylic resin, the Jaylis Decorator Screen permits free-flowing ventilation through horizontal air-vents. It filters and diffuses harsh, glaring sunlight, yet preserves privacy.

### Colorful

Three-dimensional and semi-translucent, the screen is available in a variety of decorator colors. The high reflective properties of LUCITE make the screen desirable for large expanses of sunlit areas, thus providing better room temperature control.

### Easy to clean

The screen's vertical surfaces eliminate the need for more than occasional vacuuming or dusting. Or it can be washed easily with soap and warm water.

### Durable

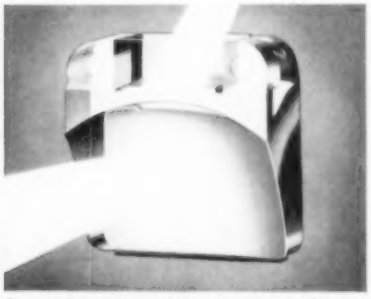
The excellent moisture-resistance of LUCITE makes it practical for outdoor applications. Even after prolonged weathering, LUCITE will not lose its transparency or become discolored by sunlight . . . won't warp or disintegrate.

### Easily fabricated

LUCITE can be worked with conventional woodworking tools, much in the same manner as wood or metal.

This versatile screen of Du Pont LUCITE suggests many uses, such as lifetime traversing window coverings, room dividers, folding doors and luminous wall screens. (LUCITE molded for Jaylis Sales Corporation, Los Angeles, California, by Southern California Plastic Company, Glendale, California.) These folding screens run on a traversing system of ZYTEL® nylon resin, molded by Coast Craft Industries, Glendale, California.

The translucent beauty of Du Pont LUCITE acrylic resin provides a perfect jewel case . . . adds extra sales appeal. (Molded for Elgin National Watch Co., Elgin, Ill., by Kent Plastics Corp., Evansville, Ind.)



Because it is easily molded and requires no finishing, LUCITE was specified for this new traffic signal finder. (Molded for Lite-Site Incorporated, Box 21, Tonawanda, N. Y., by Du Bois Plastic Products Co., Buffalo, N. Y.)

New "Mello-lite" diffuser of LUCITE prevents glare, adds to beauty of lamp. It is easily removed, easy to clean. (Molded for Sears, Roebuck & Co., Chicago, Ill., by Rupert Mfg. Co., Blue Springs, Mo.)

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PRODUCT ENGINEERING NEWS
LATEST PROPERTY AND APPLICATION DATA ON
LUCITE®

Sunburst of "Shining Hours" wall clock was molded for General Electric Co., Ashland, Mass., by Erie Resistor Corp., Erie, Pa.

## New GE clock features beauty of Du Pont LUCITE®

**Combining beauty with strength** and lightness in weight, Du Pont LUCITE acrylic resin is ideal for both decorative and functional applications.

**Its sparkling clarity** is evident in General Electric's new wall clock, appropriately called "Shining Hours."

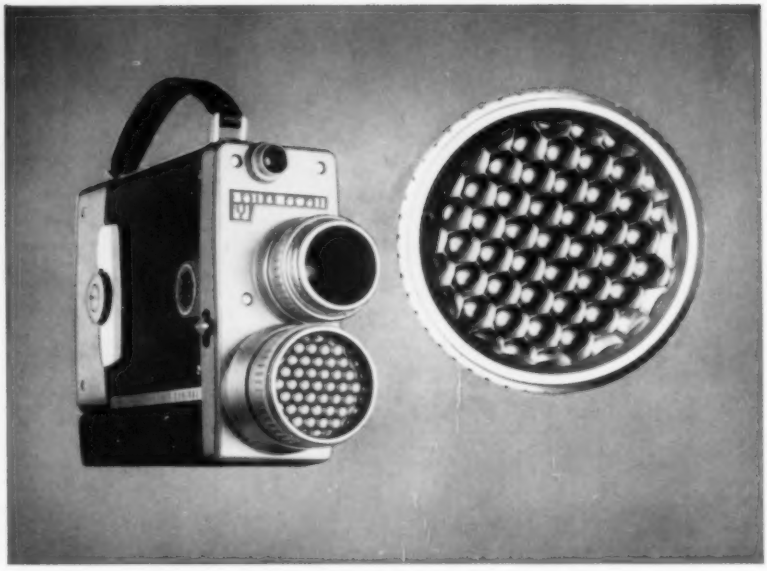
**LUCITE is available** in a wide range of colors—translucent, transparent and opaque. Or it can be back-colored for special effect. "Shining Hours," for example, is offered in clear LUCITE or dramatically back-colored in ebony-and-gold and all-gold.

**Easy to clean** with soap and warm water, LUCITE retains its luster through years of use.

**This versatile resin** retains its form stability at temperatures as high as 200°F. Since LUCITE can frequently be one-shot molded, one piece of LUCITE often replaces several difficult, involved components of other materials. The elimination of extensive welding and assembly operations considerably reduces fabrication costs. And because it is so durable, LUCITE practically eliminates shipment damage.

For more information about LUCITE, write to: E. I. du Pont de Nemours & Co. (Inc.).

# Photoelectric cell of Du Pont LUCITE® sets camera automatically



Lens for the photoelectric cell was molded for Bell & Howell Company, Chicago, Ill., by Stimsonite Division, Elastic Stop Nut Corporation of America, Chicago, Illinois.

Optical accuracy, lightness in weight, and adaptability to intricate configuration—for these reasons Bell & Howell Company of Chicago, Ill., specified Du Pont LUCITE acrylic resin in the reticular lens for the automatic exposure control of its unique 16 mm electric eye movie camera. This is the camera in which the automatic diaphragm is operated by six tiny batteries.

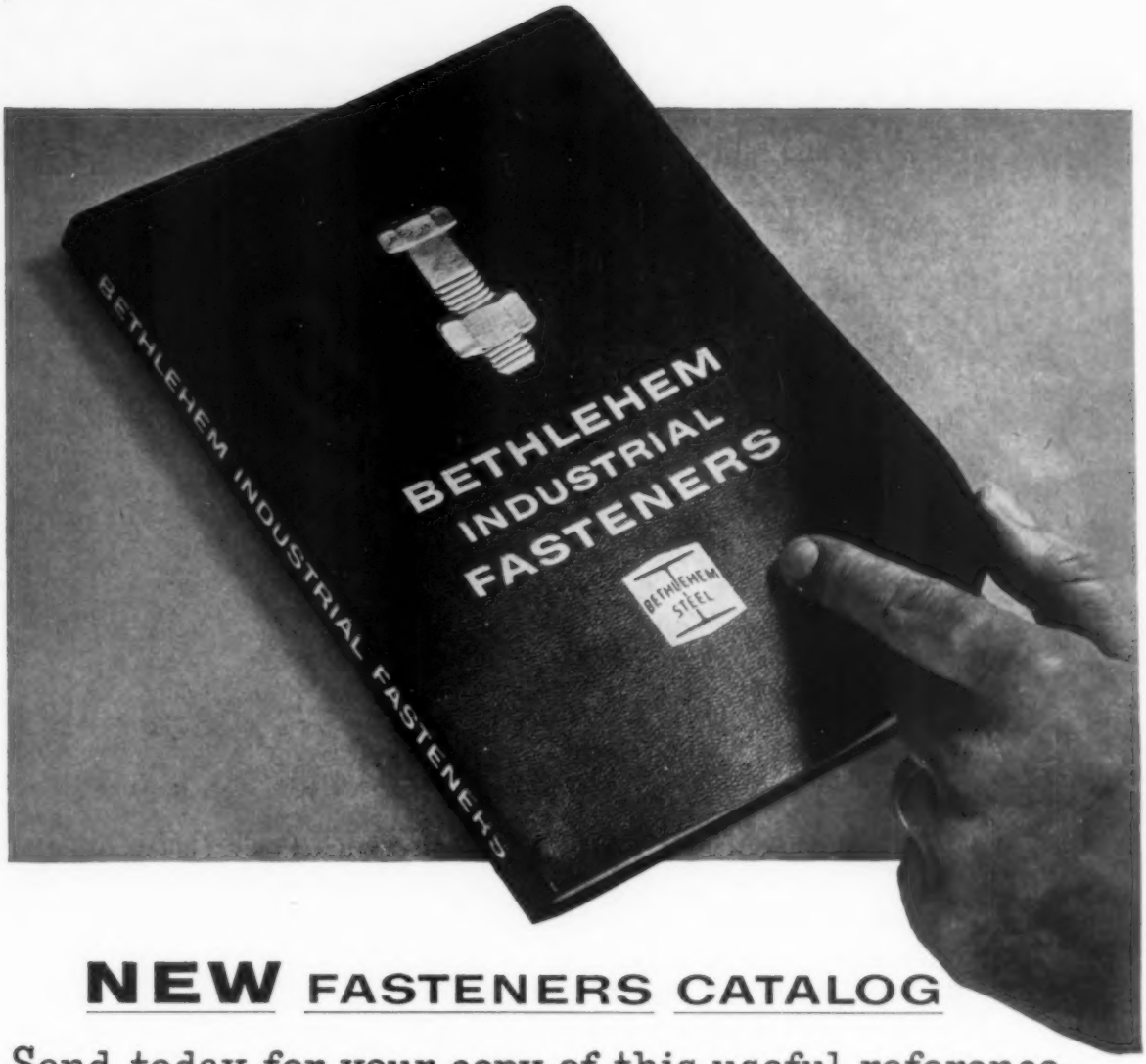
### Optically outstanding and economical

LUCITE transmits about 92% of light striking it and can be molded in sizes and shapes to fit many optical needs. Its lightness in weight (about one-third the weight of glass) is a distinct advantage in many applications. Exceptionally strong and durable, the shatter-resistance of LUCITE helps eliminate breakage and facilitates handling. Moreover, LUCITE does not become discolored or cloudy with age.

### Easy to work with

LUCITE can be fabricated to close tolerances by injection or compression molding and extrusion. Why not evaluate it for your own operation? For further information about LUCITE, write: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept., Rm. 36-4-28, Wilmington 98, Delaware. In Canada: Du Pont Company of Canada (1956) Ltd., P.O. Box 660, Montreal, Quebec.

OVER




# NEW FASTENERS CATALOG

## Send today for your copy of this useful reference, the most complete edition ever issued!

Bethlehem has just issued "Industrial Fasteners," an illustrated catalog on headed and threaded fasteners. Handsomely bound, this 164-page catalog is attractively printed in two colors; and it is packed with data on just about every type and size of fastener imaginable. List prices, dimensions, weights, and container quantities are also included.

If you have not yet received your copy, use the accompanying coupon. Simply print your name and address, clip the coupon, and mail it direct to us at Bethlehem, Pa.

Publications Department, Room 1036
Bethlehem Steel Company
Bethlehem, Pa.

Gentlemen:
I would like to have a copy of "Industrial Fasteners," your new 164-page catalog (No. 436) on headed and threaded fastener items.

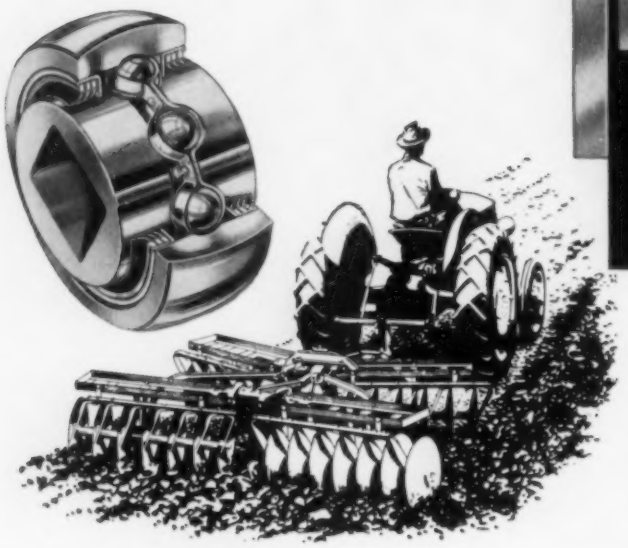
*Name*_____ *Title*_____

*Company*_____

*Address*_____

*City*_____ *Zone*_____ *State*_____

# Unique triple-lip National Syntech® seals bearings "underground" in rugged disc harrow application



**Low cost, easily installed**
**Excludes dirt, mud and water**
**Ideal for permanently lubricated bearings**
**Effective after 4,000 test hours**

The Triple-Lip Syntech seal, pioneered by National, provides a new standard of bearing protection for equipment operating in severe dust, dirt, mud and water conditions.

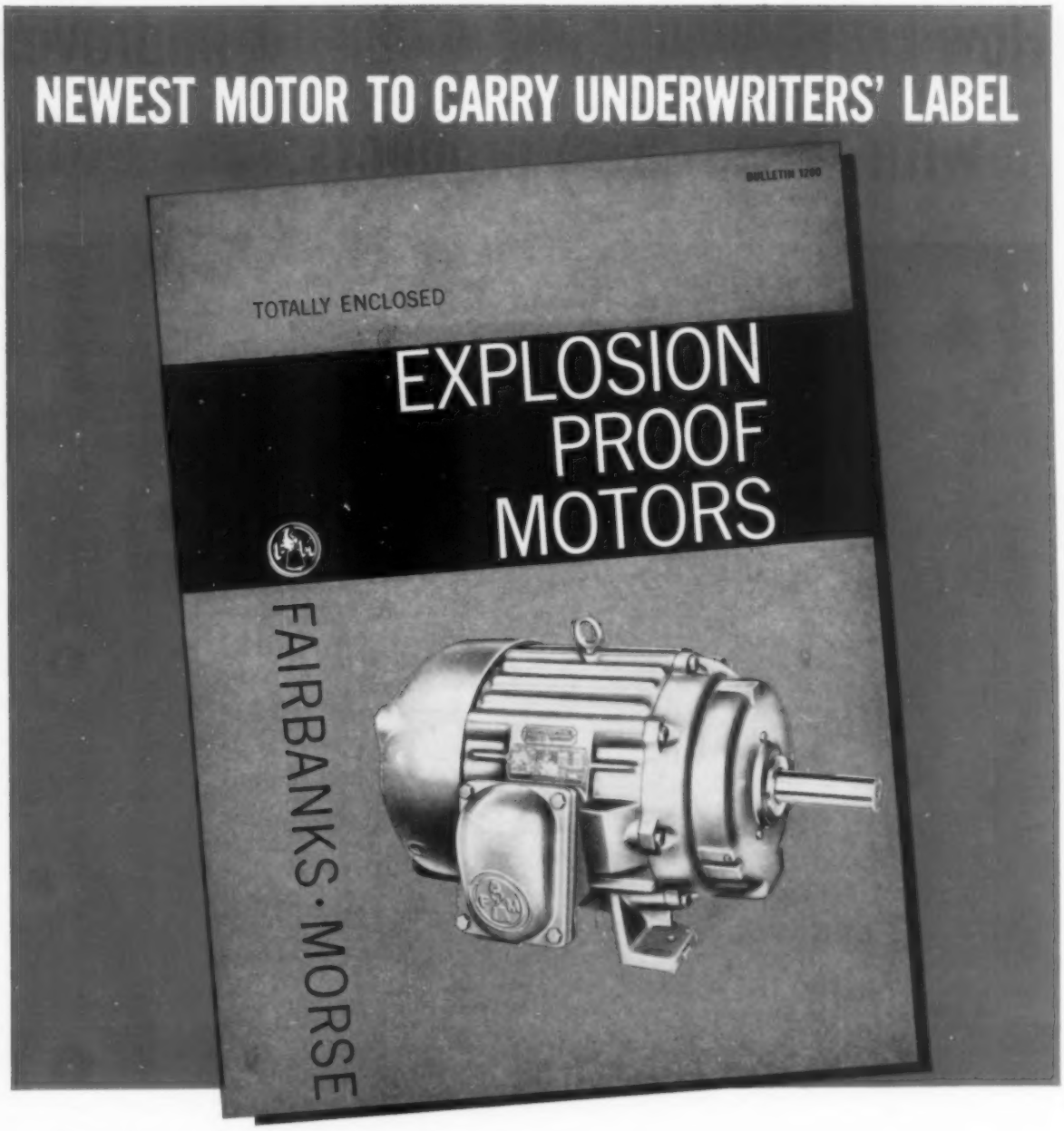
The seal is rugged and extremely simple in design. It consists of three identical synthetic rubber sealing members bonded to metal washers and enclosed in a rigid steel outer case. Use of the "straight" Syntech sections keeps torque low, simplifies flush lubrication, and permits the seal to accept a high degree of runout and misalignment where needed.

For complete information, call your National Applications Engineer or write direct

**NATIONAL SEAL**
Division, Federal-Mogul-Bower Bearings, Inc.
General Offices: Redwood City, California
Plants: Van Wert, Ohio, Redwood City and Downey, California

4540

# NEWEST MOTOR TO CARRY UNDERWRITERS' LABEL




**FAIRBANKS-MORSE**

## EXPLOSION PROOF

All new inside and out—new, rugged frame design . . . for new, improved performance in all Class I, Group D, and Class II, Group E, F and G hazardous locations.

Get full information . . . send for Bulletin 1200 on new Fairbanks-Morse line of totally enclosed, explosion-proof motors. Write today: Fairbanks, Morse & Co., Dept. PE-4-28, Chicago 5, Ill.

**FAIRBANKS-MORSE**

*a name worth remembering when you want the BEST*

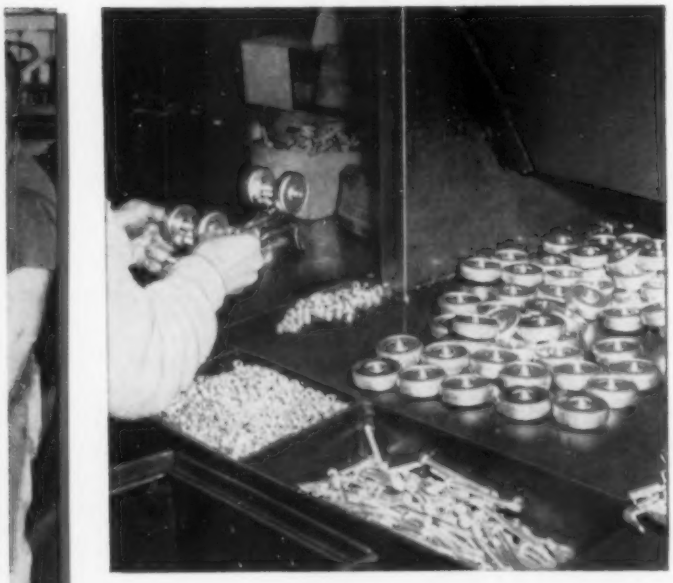
ELECTRIC MOTORS AND GENERATORS • DIESEL LOCOMOTIVES AND ENGINES • PUMPS • SCALES • RAIL CARS • HOME WATER SERVICE EQUIPMENT • MAGNETOS

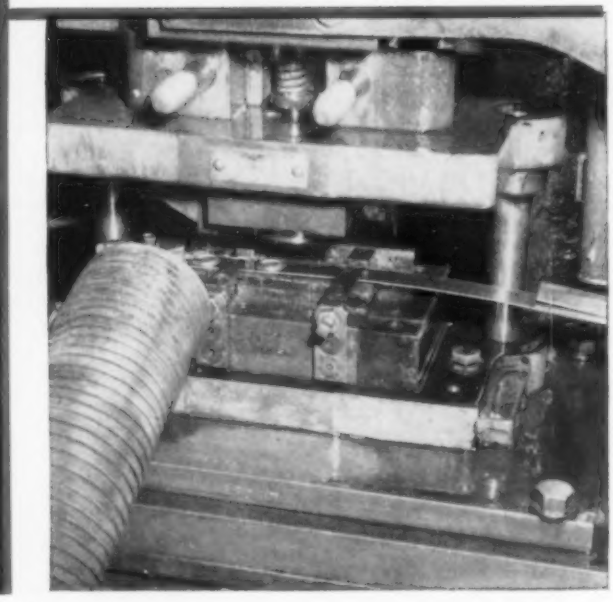
# How Frantz Manufacturing Co. improves with these USS products: Amerstrip,

**Springs with stamina.** These long-lasting American Quality Springs will go into garage doors and other Frantz building specialties. American Quality Springs are available in all sizes, shapes, and descriptions. They are inspected through every stage of the manufacture and meet the highest standards of quality.

# roller skates and garage doors

# Amerled, and American Quality Springs





AMERSTRIP IS USED in the manufacture of almost every part of the 15 types of Hustler Corporation skates made by Frantz. These skates will stand up under the punishing wear children may give them —yet maintain their attractive finish. Amerstrip is tailored to each particular job . . . has the physical properties to assure a good performance and efficient manufacture.

Tough, durable American Quality Springs play a major part in the smooth operation of Frantz garage doors. These quality springs make garage doors lower in cost and easier to operate than doors using counterweights—and they have proven equally durable.

### Amerled ups machining speed 17.4%

Frantz has been machining its own axles and bearing cones for roller skates and conveyor wheels. Recently they switched to Grade "A" free-machining USS Amerled. This easy-to-machine, lead-bearing steel meets all their requirements at lower cost as it permits them to increase machining speed from 320 to 375 S.F.M.—a 17.4% jump—with no loss in tool life . . . and less rejects.

American Steel & Wire produces a complete line of manufacturers wire products. Our large technical staff can tailor these items to fit your individual needs. Call our nearest Sales Office today. American Steel & Wire, General Offices, Rockefeller Building, Cleveland 13, Ohio.

**Precision.** In the top picture, wheels are being added to roller skates at Frantz's final assemble table. In the bottom picture, a Bliss Roll Feed Punch Press is stamping ball races from 1⅜" .047 USS Amerstrip at the rate of 195 per minute. Frantz also makes heels, toes, and channels from Amerstrip.

*USS, American, Amerstrip and Amerled are registered trademarks*

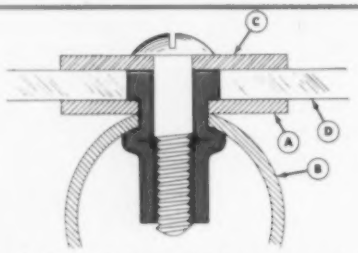
**American Steel & Wire**
**Division of USS United States Steel**

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors • Tennessee Coal & Iron Division, Fairfield, Ala., Southern Distributors • United States Steel Export Company, Distributors Abroad

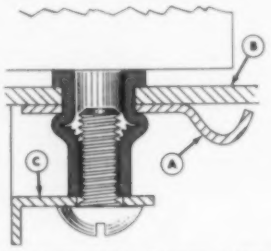
# B. F. Goodrich Rivnuts®
# save time, cut costs by doing...

B.F.Goodrich

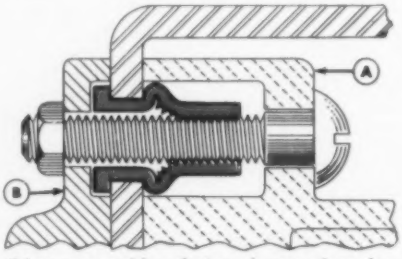
## Do you have dual fastening problems like these?




In airplane window seal, Rivnut rivets plate (A) to center post (B), provides nut plate to hold clamp strip (C). Rivnut head serves as spacer for transparent plastic sheets (D). Result: a neat, weather-tight seal!

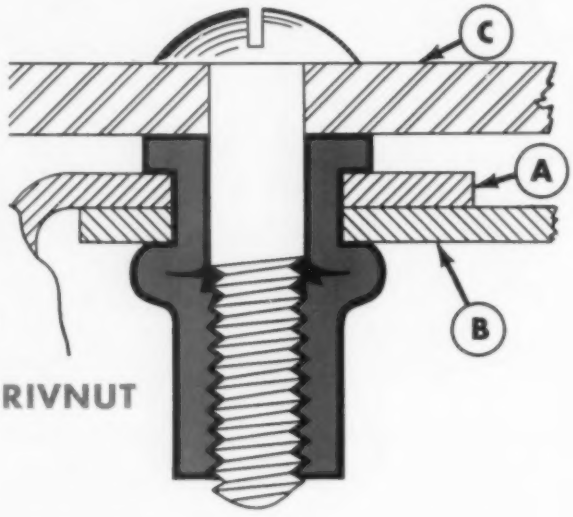



In vaporizer assembly, Rivnut rivets upper flange (A) to casing (B), makes firm, accurate nut plate for attachment to lower flange (C). Rivnut eliminates reinforcing plate. Result: less assembly time, fewer parts, better product.




Rivnut provides 6-thread nut plate for attachment from either end—or *both*. In spotlight assembly, Rivnut replaces awkward welded stud for attaching socket (A). Plug base (B) is attached on other side. Result: fewer operations, lower assembly cost.

## TWO JOBS IN ONE OPERATION




**B. F. GOODRICH RIVNUTS** cut costs and speed assembly because they rivet two parts together, make a firm, accurate nut plate for a third. And they do both jobs in one quick operation! Rivnuts can be installed from one side, take an attachment bolt from either end. They eliminate welding, tapping, clinching.

In the transformer assembly above, one worker fastens the metal cover (A) to the Glastic* sheet (B) with Rivnuts in seconds. Rivnuts then serve as mounting lugs for attaching completed transformer to mounting plate (C).

B. F. Goodrich Rivnuts have speeded up thousands of fastening jobs. They can do the same for you.

**SEND NOW FOR FREE RIVNUT DEMONSTRATOR**

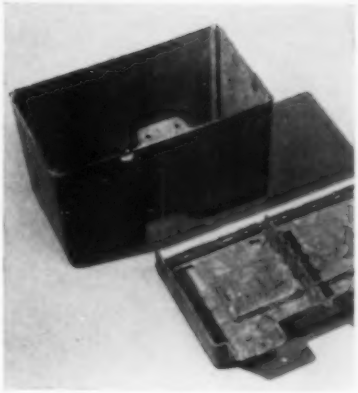
Demonstrates with motion how you can use Rivnuts to fasten WITH and TO. Explains construction, simplicity of installation. Get your free copy today by writing to: B.F.Goodrich Aviation Products, a division of The B.F.Goodrich Company, Dept. PE-48, Akron, Ohio.

*T. M. Reg. The Glastic Corp.

# B.F.Goodrich aviation products

# PRODUCT-DESIGN MEMOS FROM DUREZ

**High-impact phenolic** | **Automatic molding**
**Phenolic for appliances**



## Flying saucer?

This plastic housing helps airmen find out what's cooking on the roof of the world.

It's part of a radiosonde, a device that has sparked many flying-saucer reports.

Dropped from a high-flying weather reconnaissance plane over an ocean or arctic ice, the radiosonde flips its plastic lid, releasing a parachute.

The ballooning chute yanks an antenna line out of the case. Then, as the device drifts groundward, it broadcasts a code report on air temperature, pressure, and humidity every six seconds.

Picked up by radio men, these signals enable the Air Force to piece together accurate forecasts of flying weather over remote frontiers.

The snap-off housing is molded of *Durez 16771 Natural*, selected for its impact strength and its ability to stand extremes of temperature and humidity.

In sharp contrast to the mass production of phenolic parts, this use of Durez suggests its ability to meet *your* out-of-the-ordinary requirements.

If you'd like technical data on 16771 Natural, check the coupon. For information on other special-purpose phenolics, write us, outlining the problem.

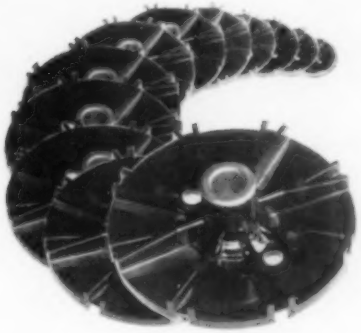
## Big job, big saving

What's hot in phenolics? *Automation.*

Automatic molding of a 4¾-inch diameter water-pump impeller for new Ford cars, trucks, and tractors has made possible a switch from cast iron to phenolic --with substantial reductions in weight, production time, and cost.

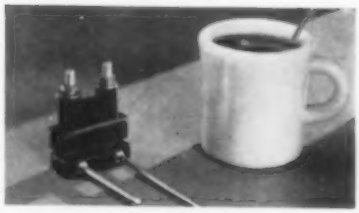
The impellers are molded 12 at a shot on the largest capacity compression molding press ever to operate on fully automatic cycle.

The material selected for the impeller is a Durez phenolic impervious to antifreeze and antirust solutions, combining moisture resistance with dimensional stability in high degree.



**Thinking big?** You'll find there are many ways in which mass-production molding and Durez phenolics can team up profitably for you. The versatility and exceptional batch-to-batch uniformity of these compounds assure best possible results on highly automated production lines.

Ask your molder or your Durez sales representative to suggest how you can put these advantages to work in your products.



## Durez and the coffee-break

Appliance makers can tell you that wherever coffee perks, bubbles, or pours into a cup, there's likely to be a Durez phenolic close by.

Electrical components, handles, knobs --these are just a few essentials of a coffee-break, in which Durez molding compounds play an unassuming part.

A prime requisite for this sort of assignment is the ability of phenolic to resist coffee stains and chemical deterioration. The appliance designer also looks for:

- excellent surface finish
- good dimensional stability
- coolness to the touch
- crack resistance when molded around large inserts

If *you're* looking for properties like these, you can find them all in *Durez 791 Black*. They're exemplified in the component shown here, an electrode assembly for a king-sized coffee maker and dispenser.

For more facts on versatile 791 Black, check the coupon.

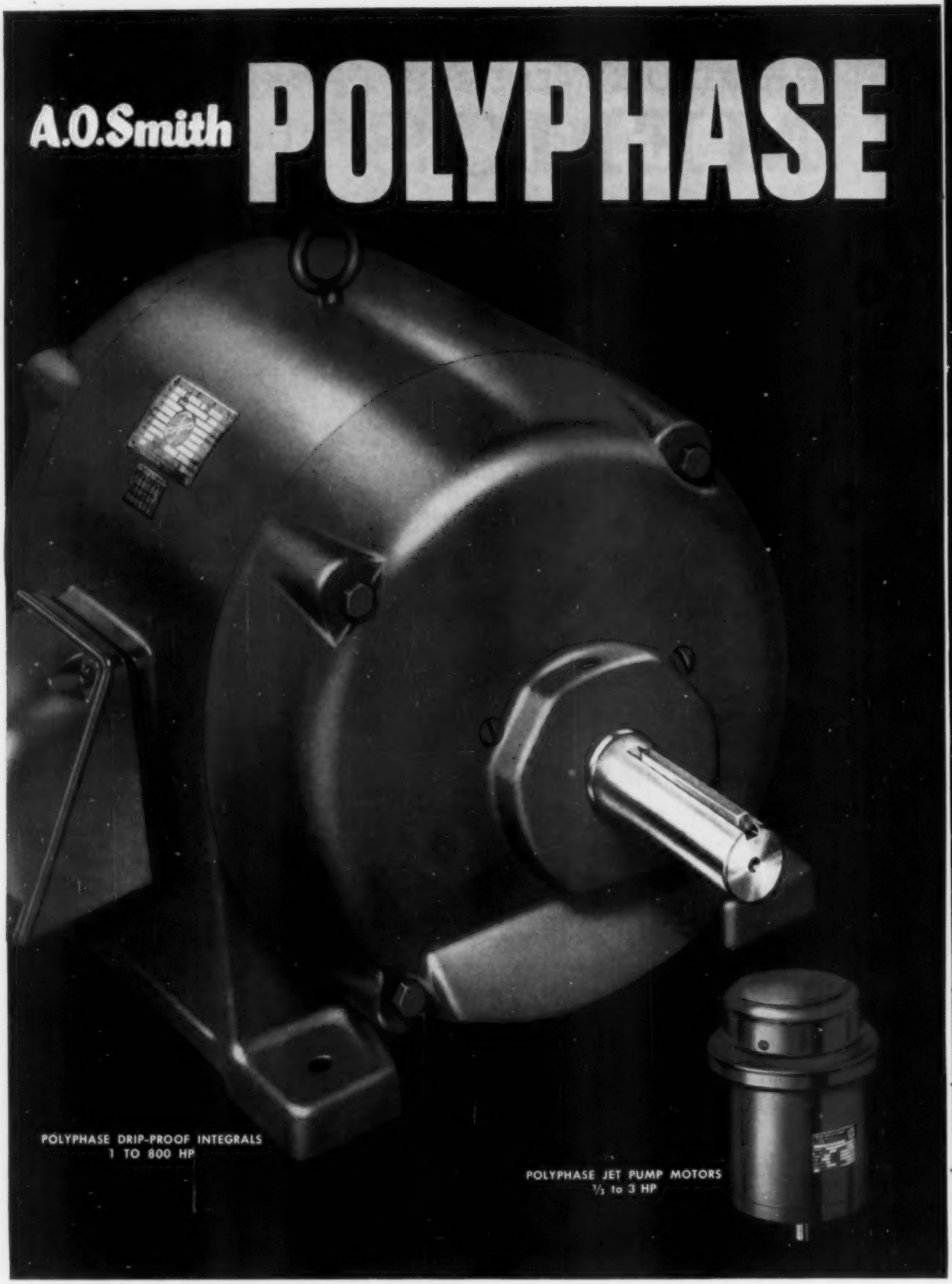
**For more information** on the Durez materials mentioned above, check here:

- ☐ High-impact Durez 16771 Natural—data sheet
- ☐ Phenolic molding compounds—descriptive bulletin
- ☐ General-purpose Durez 791 Black—data sheet

**Clip and mail** to us with your name, title, company address. *(When requesting samples, please use business letterhead.)*

DUREZ® HOOKER CHEMICALS PLASTICS

**PLASTICS DIVISION**
HOOKER ELECTROCHEMICAL COMPANY
**1504 Walck Road, North Tonawanda, N. Y.**


A.O.Smith
POLYPHASE
POLYPHASE DRIP-PROOF INTEGRALS
1 TO 800 HP
POLYPHASE JET PUMP MOTORS
½ to 3 HP

# MOTORS

## 1/3 to 800 hp

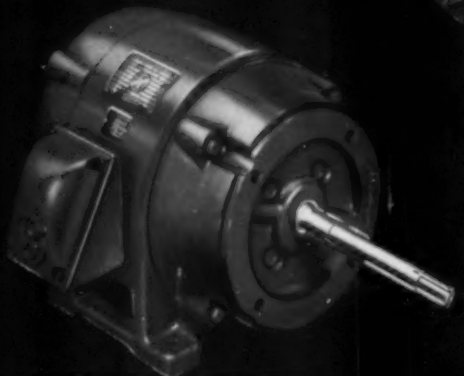
**YOURS from the case of the A. O. Smith motor man**

POLYPHASE FRACTIONALS ⅓ to 1 HP
rigid or resilient bases

VERTICAL HOLLOW SHAFT POLYPHASE
INTEGRALS 1 to 700 HP

VERTICAL SOLID SHAFT POLYPHASE
INTEGRALS 1 to 800 HP

TEFC and EXPLOSION-PROOF POLYPHASE
INTEGRALS 1 to 500 HP



CLOSE-COUPLED POLYPHASE PUMP
MOTORS 1 to 150 HP

Here's what amounts to "supermarket" variety — eight basic types of polyphase motors, each available in a wide range of sizes and with practically any electrical or mechanical modification needed.

But in addition to wide choice that helps you get the motor best suited for your application, you get scores of quality features that pay off in uninterrupted service, longer operating life, lower maintenance cost. Every motor is designed to offer ample protection against temporary overloads or voltage drops. You get balanced insulation to afford maximum protection against phase-to-phase or phase-to-ground breakdowns during high amp surges.

All the engineering assistance you want or need is available for designing a motor into your product or applying standard models. What's more, many models are available from stock, in both old and current NEMA frame sizes.

For complete details, contact your A. O. Smith motor man or write direct.

**GEARMOTORS 1 to 25 HP are also available with electrical or mechanical modifications to meet your specific requirements.**

*Through research ...a better way*

**A.O.Smith**
CORPORATION

**ELECTRIC MOTORS**
Tipp City, Ohio
A. O. Smith International S. A., Milwaukee 1, Wisconsin, U. S. A.

NEWS FROM FLEXONICS

# HOSE APPLICATION ENGINEERING

One of a series of reports on more effective use of flexible hose.

## HOW TO DETERMINE MAXIMUM PRESSURE

for connections made with flexible metal hose

Determination of maximum allowable pressures for metal hose connections has long been surrounded with confusion. A mass of conflicting information has made the designer's job unnecessarily difficult. Recognizing these problems, Flexonics Corporation has developed simple procedures for establishing connector specifications to meet required pressure requirements.

### Four Factors Influence Pressure Limitations

In arriving at the maximum allowable pressure for any flexible metal hose connector four factors must be considered:

1. Size, type and material of hose.
2. Method of fitting attachment.
3. Service temperature of hose assembly.
4. Nature of pressure (constant, pulsating or shock).

No connector can be properly designed without consideration of *all* of these factors.

*Type of Hose*—The size, construction and type of metal of a given piece of hose determine its ability to withstand pressure. The Flexon Metal Hose Design Guide gives maximum allowable pressure for all types, sizes and materials of Flexon metal hose. Use these values as the basis of your calculations.

*Method of Fitting Attachment*—The manner of fitting attachment frequently modifies the maximum pressure rating of a hose assembly. Following are factors for calculating the constant working pressure rating of hose assemblies: (In all cases multiply the maximum allowable pressure as given in Flexon hose specifications by the factor to get maximum constant working pressure.)

**I Soft Solder Fittings:**

A. For bronze or steel hose: 1.25
B. For stainless steel hose: 1.00

**II Rex-Tite Mechanical Reusable Fittings:**

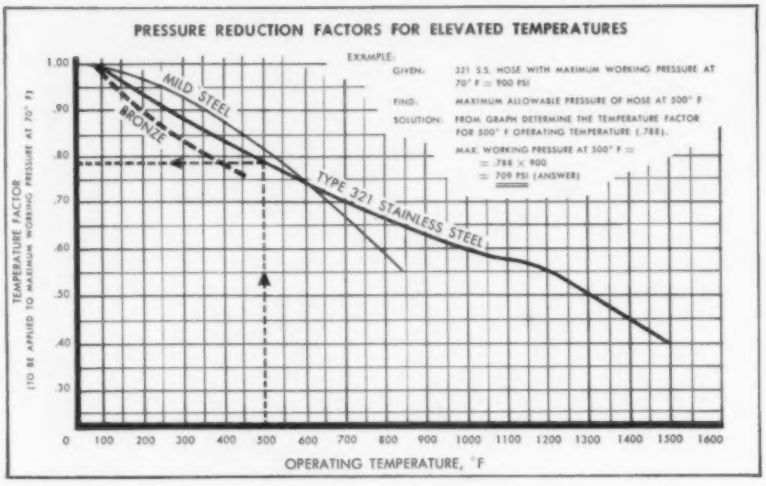
A. For braided bronze or steel hose: 1.10

**III Packed-On Fittings:**

A. For interlocked Rex-Tube pressure hose: 1.00

**IV Brazed or Welded Fittings:**

A. For bronze or steel hose: 1.00


PRESSURE REDUCTION FACTORS FOR ELEVATED TEMPERATURES
EXAMPLE:
GIVEN: 321 S.S. HOSE WITH MAXIMUM WORKING PRESSURE AT 70° F = 900 PSI
FIND: MAXIMUM ALLOWABLE PRESSURE OF HOSE AT 500° F
SOLUTION: FROM GRAPH DETERMINE THE TEMPERATURE FACTOR FOR 500° F OPERATING TEMPERATURE (.788).
MAX. WORKING PRESSURE AT 500° F =
= .788 × 900
= 709 PSI (ANSWER)
MILD STEEL
BRONZE
TYPE 321 STAINLESS STEEL
TEMPERATURE FACTOR (TO BE APPLIED TO MAXIMUM WORKING PRESSURE AT 70° F)
1.00
.90
.80
.70
.60
.50
.40
.30
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600
OPERATING TEMPERATURE, °F

B. For stainless steel hose —
   1. attachment by silver brazing: 1.00
   2. attachment by atomic hydrogen welding: 0.65.
   3. attachment by Heliarc welding, braid sleeve type construction: 0.80.
   4. attachment by Heliarc welding, welding ring type construction: 1.00

*Service Temperature of Assembly*—Maximum allowable pressures for Flexon metal hose are given for 70° F. Hose assemblies to be used at temperatures above this must have a reduction factor applied. The graph above shows these factors for three of the metals most commonly used in hose construction. Apply this factor to the pressure value determined by applying the fitting factor to maximum allowable pressure of the hose.

*Nature of Pressure*—Whether the pressure is constant, shock or pulsating has an important effect on maximum allowable pressure for a hose assembly. For constant pressure, no factor is required. However, for shock and pulsating pressures, a factor must be applied to compensate for stresses set up by this type of pressure.

Working pressures for pulsating conditions are normally ¼ the constant working pressure.

Working pressures for shock conditions are normally 1/6th the constant working pressure, where the duration of shock pressure is up to 3 seconds.

These factors are based on extensive laboratory testing. However, for critical applications check with your Flexonics sales engineer.

### Design Assistance

Further information on all aspects of hose design is presented in the 36-page Flexon Metal Hose Design Guide. You'll find this to be the most complete and authoritative handbook on metal hose design problems. Be sure and have a copy in your files. It's yours for the asking. Write today.

If you have a specific design problem, Flexonics' design engineers will be pleased to assist you. Just send an outline of your requirements.

**HOSE DIVISION**
MH-41

**Flexonics** *Corporation*

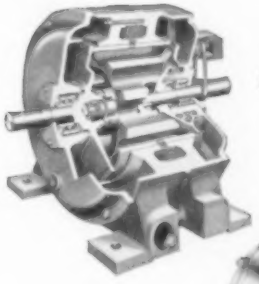
**1351 S. THIRD AVENUE • MAYWOOD, ILLINOIS**
**In Canada: Flexonics Corporation of Canada, Limited, Brampton, Ontario**
**Also Manufacturers of Rubber and Metal Hose Assemblies • Expansion Joints • Aircraft Components**

# When You See this Nameplate— You Know Someone Has Solved a Problem!

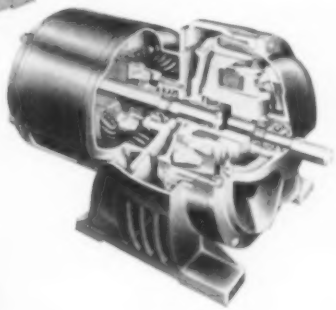
Your problem may be in the field of speed control, tension control, power transmission, or testing. Dynamatic Eddy-Current Equipment—couplings, brakes, drives, dynamometers—is solving these problems in virtually every industry, in both plant equipment and end products. It can do the same for you.

Dynamatic units offer the important advantages of rapid response, wide speed range, quiet operation, low power loss, low maintenance costs, and stepless adjustable speeds from an AC power source.

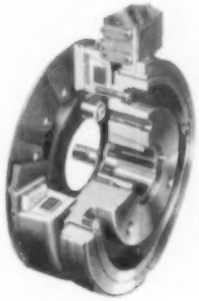
And Eaton Dyna-torQ magnetic-friction industrial clutches and brakes are solving driving and braking problems in all industries where accurate start-and-stop control is required. Check with the Eaton Dynamatic representative or distributor in your locality, or—



DYNAMATIC EDDY-CURRENT COUPLINGS AND BRAKES



DYNAMATIC AJUSTO-SPEDE® AND DYNA-SPEDE® DRIVES



DYNA-TORQ MAGNETIC-FRICTION CLUTCHES, BRAKES, CLUTCH-BRAKES, CLUTCH-COUPLINGS

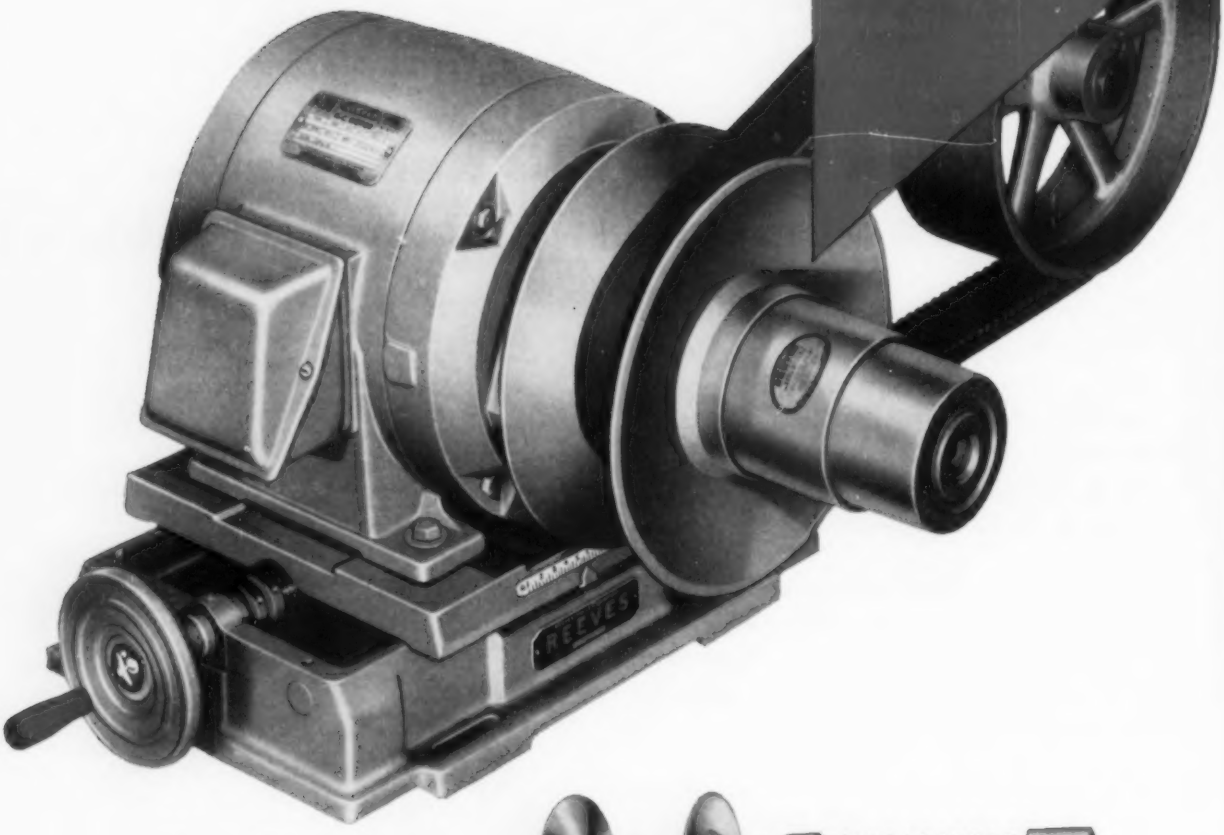
*Send for Illustrated Descriptive Literature*
*Covering Dynamatic Eddy-Current and Dyna-torQ Equipment*

**EATON**

**DYNAMATIC DIVISION**
**MANUFACTURING COMPANY**
**3307 FOURTEENTH AVENUE • KENOSHA, WISCONSIN**

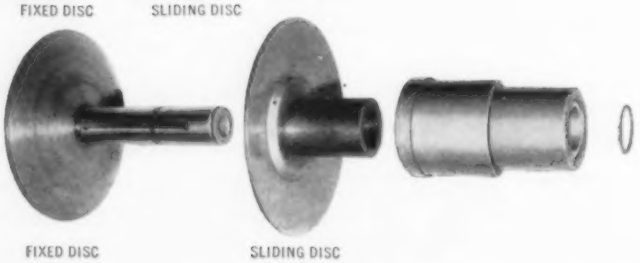
# REEVES®

*vari-speed* **MOTOR PULLEY**




**Sizes 95 and 96** Two-part spring cover, belt tension spring, and retaining ring.

**Sizes 97 through 912-15**
Pre-loaded safety cartridge for belt tension spring, and retaining ring.



● Here is variable speed control in its most simplified form . . . variable speed control with new economy . . . made possible because the new REEVES Vari-Speed Motor Pulley disc assemblies and bases are the simplest components available.

Disc assemblies have just three main parts: two smooth-face, cone-shaped discs —one mounted in fixed position on the motor shaft, the other designed to slide laterally on the hub of the fixed disc; and the belt tension spring. Belt tension spring automatically maintains pressure on the sliding disc for correct belt tension at all output speeds.

There are no other wearing parts to give maintenance trouble. Compact disc assemblies available in nine sizes, ½ hp. through 15 hp., to fit old and new NEMA motors.

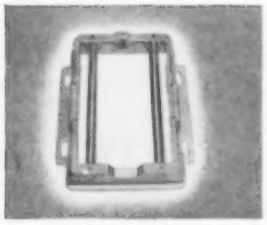
Separately mounted countershaft assemblies, in three sizes to match REEVES motor bases, are available to step-up or step-down output speeds.

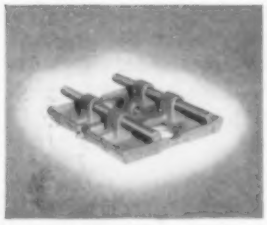
For complete information on Motor Pulley sizes and available controls, write for Bulletin K35-V582.

*completely redesigned*

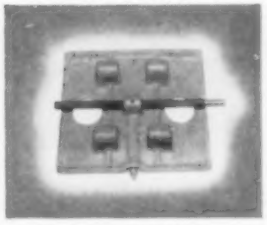
Split-section view of sliding disc shows how REEVES exclusive "close grooving" maintains film of lubricant between hub length of fixed disc and bore of sliding disc. No metal-to-metal contact . . . no "fretting" corrosion. One lubrication point services entire disc assembly, virtually eliminating sticking discs.

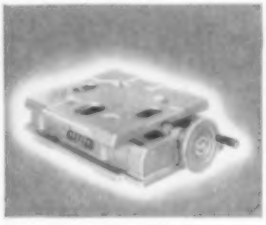
**New precision bases**—Four compact sizes to accommodate old and new NEMA motors in ½ through 15 hp. Sturdy, durable bases are manufactured on special automatic equipment to assure positive, easy adjustment and accurate speed control.





Base and motor slide rods manufactured for precision fit and true alignment.





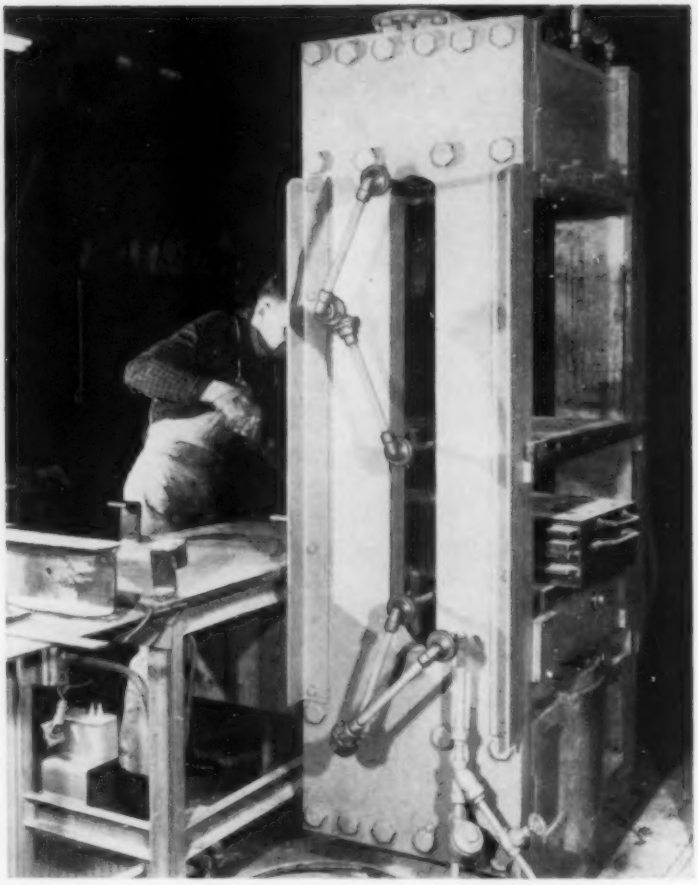
Fully-lubricated shifting screw and precision features provide easy shifting.

**REEVES PULLEY COMPANY**

*Division of* **RELIANCE** ELECTRIC AND ENGINEERING CO.

Columbus, Indiana

**STEEL LINES FOLD LIKE AN ACCORDION**
Typical of diverse swivel joint applications, newly designed Chiksan Discpak joints are installed on the steam lines of a platen press. This new type swivel joint, designed for hot gas and steam, allows inexpensive packing replacement without removing swivel joint from line.



WHEN *design*
DICTATES
METAL LINES . . .

# SOLVE LINE FLEXING PROBLEMS

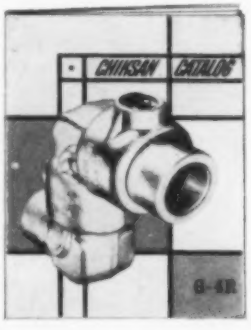
*with* **CHIKSAN** SWIVEL

Chiksan swivel joints allow metal lines to be flexed in predetermined travel arcs, eliminate hose rupture, reduce maintenance and replacement costs.

Where tight bends in pressure hose make wide loops necessary, Chiksan swivel joints, conversely, permit compact placement of lines. When used with hose, Chiksan swivel joints shorten hose lengths and also lengthen hose life by minimizing tight bend and torsional fatigue.

Chiksan swivel joints are available from stock in a wide range of materials, temperatures, and pressures to meet practically every design requirement. Chiksan swivel joint packing units are designed for specific services. For example, packings have been developed to efficiently handle non-inflammable hydraulic fluids. Write today for catalog and name of nearby sales engineer.

**LONG SERVICE LIFE** ➤
Chiksan swivel joints deliver years of service with only occasional maintenance attention. All-steel hydraulic lines on Flash-Butt welder, shown at right, allow lines to shift as machine is adjusted to handle various work.

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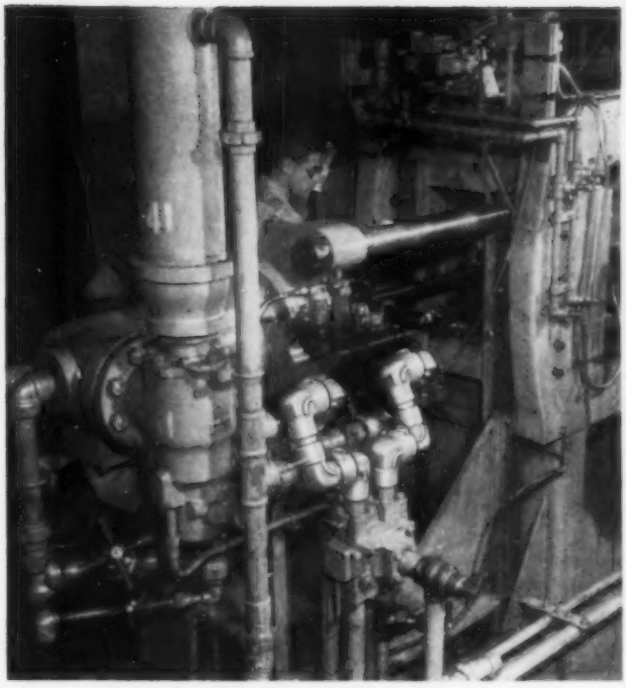
CHIKSAN

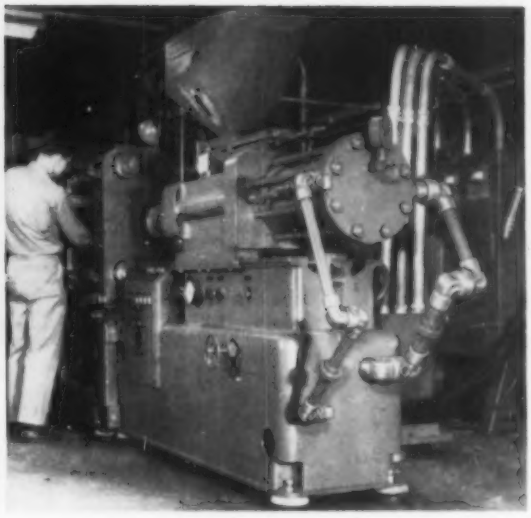
**CHIKSAN COMPANY**–BREA, CALIFORNIA • CHICAGO 5, ILLINOIS • NEWARK 2, NEW JERSEY

Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Subsidiaries: Chiksan Export Company • Chiksan of Canada Ltd.



**NO HOSE BURST DANGER HERE...**

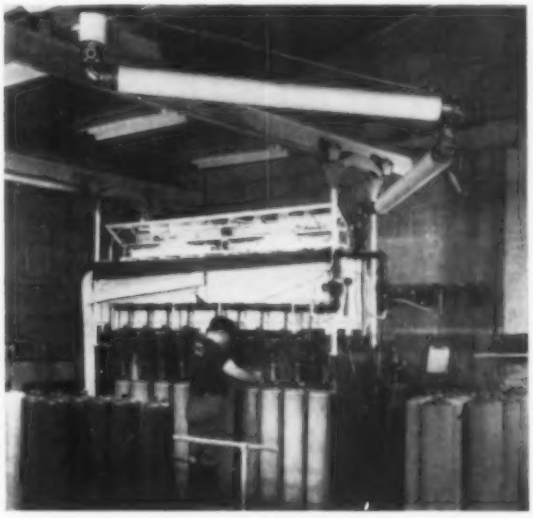
Critical lines take on a new measure of safety with all-steel flexible units replacing pressure hose. These all-metal swivel jointed lines shown on a die casting machine above, eliminate damaging hose ruptures, and reduce fire hazard, fluid loss and setup time by 75%.



**PRESSURE? TEMPERATURE? CHIKSAN MEETS THE NEED...**

Over 2,000 different types, styles and sizes in a variety of temperature and pressure ratings are available to meet your design needs. This plastic injection molding machine, above, uses two different sizes of Chiksan swivel joints on its hydraulic lines.

# JOINTS



**NO LIMIT ON LINE DESIGN**

Free swiveling action in 1, 2 and 3 planes permits design of compact lines to meet any requirement. This overhead line in service at a water softener regenerating plant permits shift from one setup of tanks to another for faster handling of tank regeneration.

#58-31

**CHIKSAN COMPANY**
**330 NORTH POMONA AVENUE, BREA, CALIFORNIA**

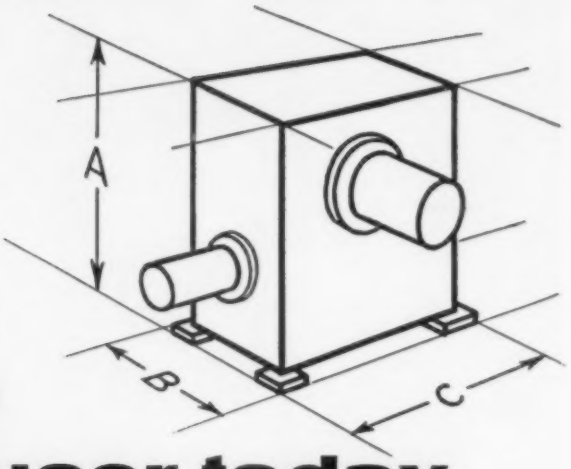
*Please send me copy of your latest catalog*

Name_____ Company_____

Title_____ Address_____

City_____ Zone_____ State_____

## *Do-It-Yourself...*




# Let's design a speed reducer today

So you can't find a speed reducer to fit your latest brainchild without ruining the design? Doggone manufacturers all build reducers too big to fit into those few cubic feet you've got left for the reduction unit back behind the double-ended dingbat?

Revolt! Design your own! Show 'em!

By George, design it yourself and it'll fit. How? Well, you know your size limits. Draw the biggest box that'll fit the space and you've got your reducer housing specifications.

Now you need gears that will (1) transmit the needed horsepower under all operating conditions, (2) provide the ratio your machine requires and (3) fit the space that's available. You'll soon discover that there are limits to what gears can do in transmitting horsepower. The cheapest answer is parallel shaft helical gears. If they'll fit you're in clover. But they take the most room, especially when you're out of the fractional hp range. The right angle worm and gear combination is the most compact drive arrangement.

Here again you have a choice. Cylindrical worm gearing is often used, and if it'll do the job, is worth consideration. But it's not the most compact possibility. The best way to shrink gears and still carry the load is the double-enveloping worm gear design. Both worm and gear are throated and the two literally wrap around each other. This brings center distance of the two shafts closer together and you can put them inside smaller housings.

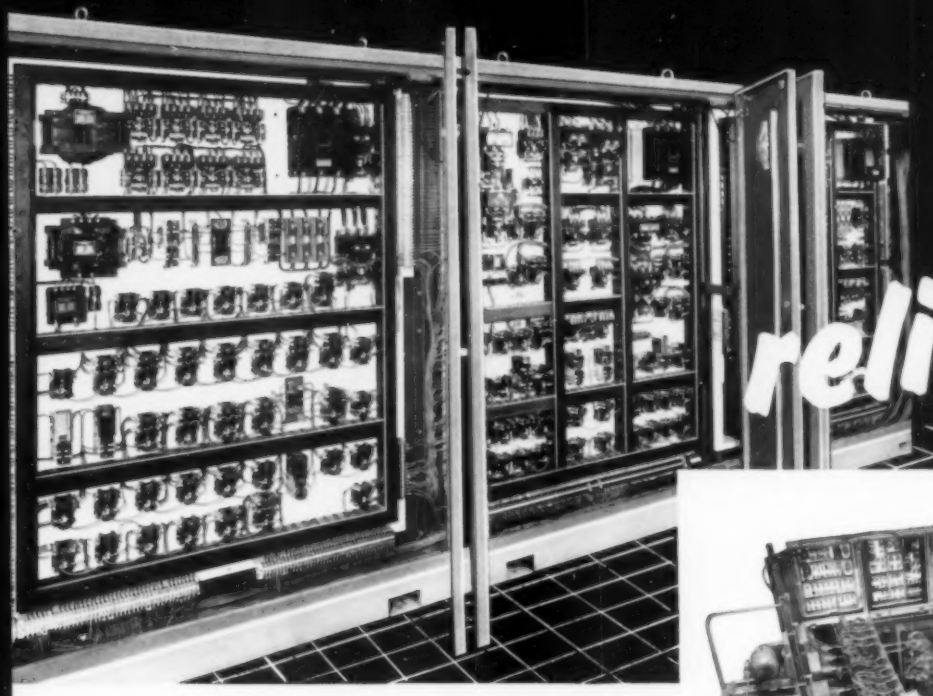
Does this reduce load capacity? No sir! You can carry the same load with center distances up to 33% smaller than those of cylindrical worm gears. Or use the same center distance and carry a greater load. Will these gears hold up in operation? Sure, if you beef up the teeth, the bearings and the housing. Use straight-sided worm and gear teeth and you'll get all the strength there you'll ever need. Use large taper roller bearings with real B-10 life. Use a reinforced, heavy wall housing that won't distort under load. Put fins on it for added cooling and increased thermal horsepower capacity to meet your needs. Now, put the whole thing together and you've got a speed reducer that's a dilly.

Designing your own speed reducer give you a headache? Looking for an easier way? There is one. Someone's already done exactly what you're talking about. You can order that compact speed reducer right off the shelf. Where?

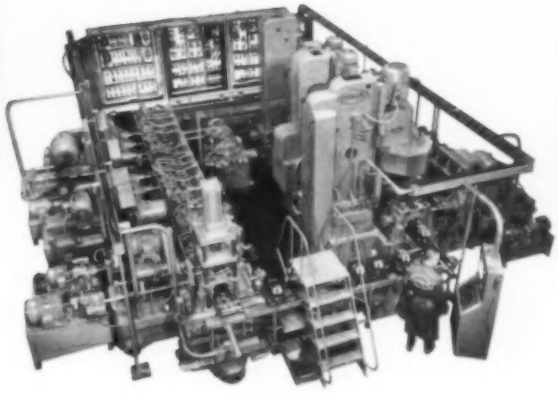
Cone-Drive Gears, that's where!

Yes sir. They stock double-enveloping worm gear speed reducers from fractional to 665 hp. Standard ratios from 5:1 to 70:1 in about 15 increments, all interchangeable in any type housing of a given center distance. Worms over and worms under. Gear shafts vertical, too. Single- or double-extended output shafts, or shaft mounted. Over 200,000 combinations possible. Wow! Just about anything you want.

Better get Cone-Drive's new speed reducer catalog that details everything. Ask for Bulletin CD-218. Cone-Drive Gears, Div. Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.



# preferred . . . because it is reliable!



This Baker Automatic Transfer Machine is equipped with a special Allen-Bradley control panel, assembled from standard components listed in the latest A-B Handy Catalog.

## ALLEN-BRADLEY MOTOR CONTROL

QUALITY

Twenty-six machining operations are performed automatically on this huge transfer machine. To keep this machine operating continuously—to avoid costly production shutdowns—Baker Brothers, Inc., selected Allen-Bradley quality motor control—the simple control that is good for millions of trouble free operations.

The recognized reliability of Allen-Bradley motor starters and relays is the result of their simple design. Having only *one* moving part, wear and consequent trouble are reduced to the minimum. The double break, silver alloy contacts . . . standard throughout the Allen-Bradley line . . . never need attention. They are always in perfect operating condition.

Simplicity of design and silver alloy contacts are features of all Allen-Bradley control auxiliaries—they are similarly trouble free. Therefore, standardize on the Allen-Bradley line of *quality* motor starters, relays, push buttons, limit switches, and other accessories. You cannot possibly make a mistake!

**Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.**

**In Canada: Allen-Bradley Canada Ltd., Galt, Ont.**

BULLETIN 802T
Oiltight
Limit Switch

Has completely sealed operating head and switch body. This adjustable roller lever type saves installation time.

BULLETIN 700
Solenoid Relay

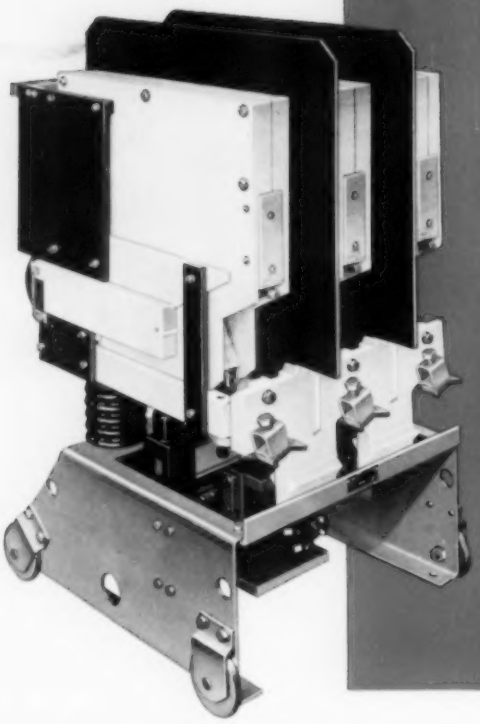
Universal type relay has contacts that can be connected for either "normally open" or "normally closed" operation.

BULLETIN 709
Solenoid
Starter
(Size 1)

Popular across-the-line starter with accurate and reliable overload relays. 8 Sizes to 300 hp, 220 v; 600 hp, 440-550 v.

4-58-R

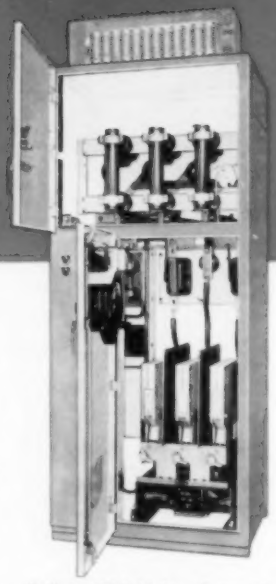
A-B
QUALITY



# Air break starters

## for high voltage motors

A-B QUALITY



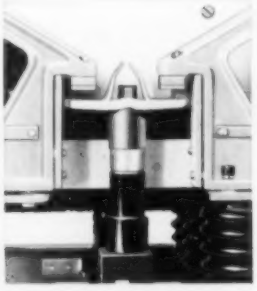
Bulletin 966 high voltage air break, across-the-line synchronous motor starter in NEMA Type 1 enclosure.

This *new* air break contactor—around which Allen-Bradley has developed a complete line of high voltage starters—is designed to match your *toughest* applications. It features the same solenoid design—with only *one* moving part—that has made Allen-Bradley low voltage starters universally recognized for their tremendous operating life.

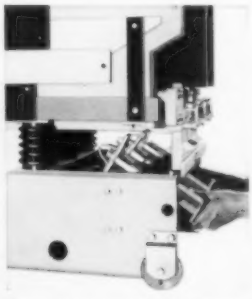
These new contactors are available in full voltage and reduced voltage starters—nonreversing or reversing—for squirrel cage, part winding, slip ring, and synchronous motors up to 1500 hp, 2300 volts; 2500 hp, 4600 volts. All starters are equipped with current limiting fuses and have an interrupting capacity of 150,000 kva at 2300 volts and 250,000 kva at 4600 volts.

It will pay you to investigate these *quality* starters. Complete information is contained in Publication 6080 . . . please send for your copy, today.

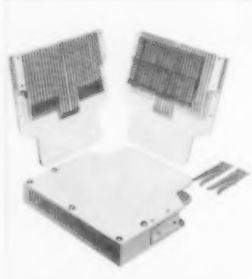
**Only One Moving Part.** Simple solenoid design eliminates trouble-causing pins, pivots, and flexible jumpers.



**Double Break Contacts** of silver alloy never need maintenance. Vertical motion assures uniform contact pressures.



**Easy Access from Front.** Crossbar and contacts removable from front, without special tools, for easy inspection.



**Faster Arc Suppression.** New blowout design and novel arc chute. Chutes are molded from an arc resistant material.

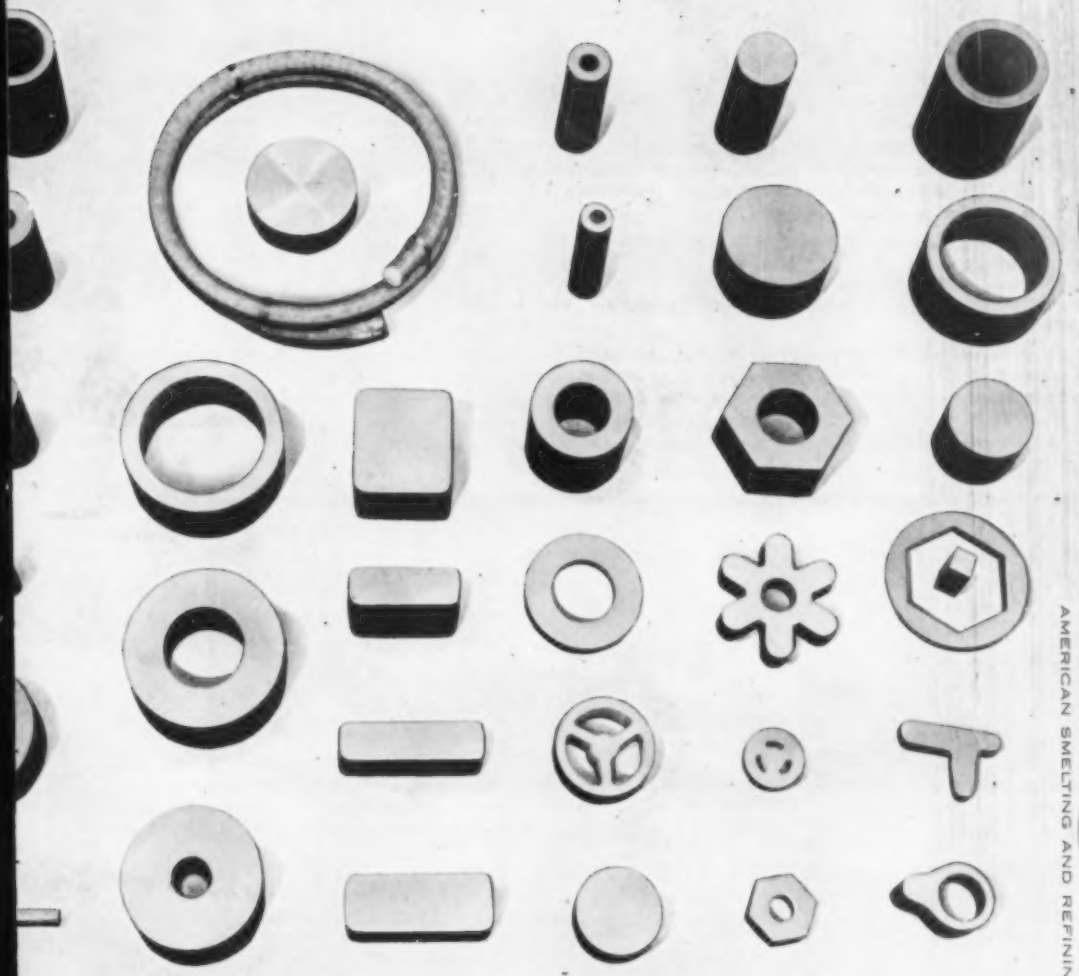
**Allen-Bradley Co.**
**1316 S. Second St.**
**Milwaukee 4, Wis.**
**In Canada: Allen-Bradley Canada Ltd.**
**Galt, Ontario**

4-58-MR

**ALLEN-BRADLEY**
**MOTOR CONTROL**
QUALITY

***In continuous lengths:*** the bronze casting you want in the shape you want! The advantages of custom-shapes in long lengths instead of individual castings. The uniformity and machinability of bronze alloys with no hard or soft spots: no sand, dirt, or dross to dull tools or reduce cutting speeds. The superior physical characteristics of continuous cast bronzes: impact, tensile, and yield strength, and hardness, improved as much as 100% over the same alloys cast by other methods. Asarco will custom cast practically all standard tin-bronze alloys in the shapes, lengths and diameters you need. Asarcon 773 (SAE 660), general purpose bearing bronze, is available from stock in 260 standard sizes, solids and tubes. Check with your local Asarco distributor or write: Continuous-Cast Products Dept., American Smelting and Refining Company, Barber, N. J., Kingwell Bros., Ltd., 457 Minna St., San Francisco. In Canada: Federated Metals Canada, Ltd., Toronto and Montreal.

**CONTINUOUS-CAST DEPARTMENT OF**



# ASARCO

AMERICAN SMELTING AND REFINING COMPANY

engineering report...

# MINIATURE BEARING LIFE

ED BERGETHON
Director of Engineering
Reed Instrument Bearing Company

The useful life of an instrument ball bearing cannot easily be predicted by mathematical analysis. Empirical formulae and classic data on the subject omit considerations of the bearing retainer material and design, yet the quality and hardness of the retainer has been found to be of paramount importance in the ultimate reliability of the system in which the bearing is placed.

Careful analysis of miniature bearing applications has proven conclusively that the large majority of "failures" is directly traceable to the high "wearout rates" of the retainers used by most manufacturers. This is particularly true in light load, medium-high speed applications.

Retainer wear takes place in the ball pockets and on the control surface. Unfortunately, while the wear rate can be experimentally predicted, its two most harmful results cannot. These are: 1) the effect of products of abrasion on bearing operation, and 2) misalignment and freezing of the bearing due to excessive retainer clearance.

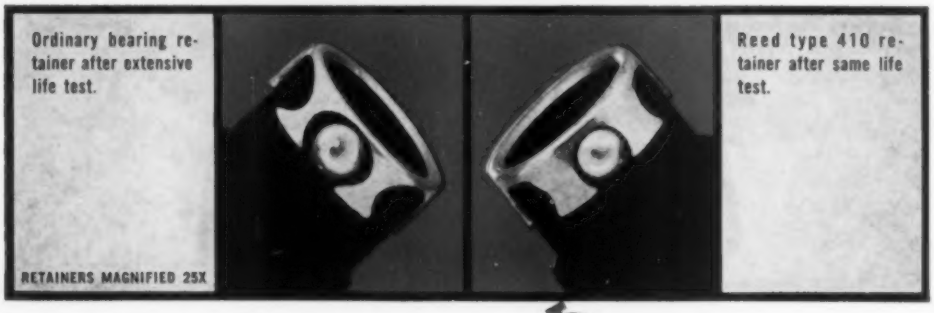
Although many special applications require unique retainer design, the open-end or crown type retainer is the most useful, general purpose type. It offers light weight, strength, minimum moment of inertia and minimum area to hamper lubrication. Unless properly designed and fabricated, however, these virtues cannot be realized in reliability.

At Reed Instrument Bearing Company we have discarded classic soft retainer materials in favor of martensitic materials capable of through-hardening for maximum wear resistance and strength. The use of stainless type 410 steel at maximum hardness provides, in addition:

a. good hot hardness properties in medium temperature ranges,
b. a thermal coefficient of expansion very close to stainless type 440c, of which rings and balls are made, and
c. a high index of thermal conductivity.

**If you have an instrument bearing problem, talk to the man who knows miniature bearings best. Call Ed Bergethon at Reed Instrument Company today.**

**(Send for Reed's new instrument bearing engineering catalog 120, free.)**


Ordinary bearing retainer after extensive life test.
RETAINERS MAGNIFIED 25X
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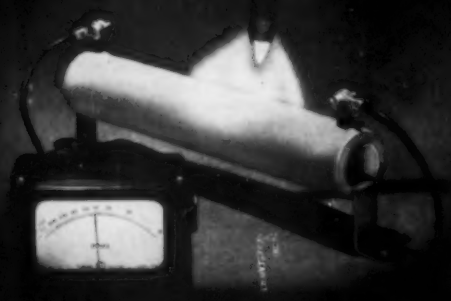

Stable operation from +700° F . . .

. . . to −70° F

Enamel resists active chemicals

Terminals withstand 21 lbs. pull

## *LABORATORY TESTS PROVE . . .*

# G-E resistors withstand heat, chemicals, stress

Actual laboratory tests on General Electric vitreous-enameled resistors have proved these important points:

**Stable operation** was proved by subjecting General Electric resistors to extreme ambient temperatures. Results of test: G-E resistors maintained their rated ohmic values under temperatures ranging from +700°F to −70°F.

**Long operating life** of G-E resistors is a result of sealing the windings with a special vitreous-enamel coating. This coating was tested with solvents, alkalies and other active chemicals. Result: no adverse effects from prolonged exposure to active chemicals.

**Fewer replacements** are necessary because of the sturdy construction of G-E resistors. Standard terminals hold up to 21 pounds of right-angle pull! (Special terminals withstand up to 34 pounds!)

Order G-E resistors today! Select from over 1400 combinations of ratings (5 to 200 watts), types and mountings.

### NEED OTHER COMPONENTS?

General Electric also has complete lines of contactors, relays, and plate rheostats for all your control needs. For more information, contact your G-E Sales Engineer or mail this coupon today! Industry Control Department, Roanoke, Va.

# GENERAL ELECTRIC

**D-c contactors and relays**—feature new "building-block" construction to give maximum flexibility with minimum inventory.

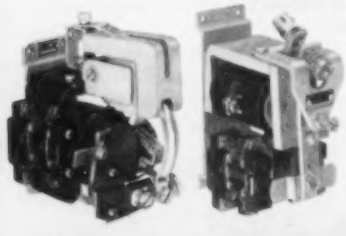

**Plate-type rheostats**—windings are completely encased in metal to give longer and more reliable service for any application.

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General Electric Co.
Schenectady 5, N. Y.

Please send the following bulletins:

- ☐ GEA-6592—Vitreous-enameled resistors
- ☐ GEA-6474—Plate-type field rheostats
- ☐ GEA-6621—D-c contactors and relays

Name_____

Company_____

Address_____

City_____ State_____

# DESIGNING WITH ALUMINUM

This is one of a series of information sheets that discuss the properties of aluminum and its alloys with relation to design. Extra or missing copies of the series supplied on request. Address: Advertising Dept., Kaiser Aluminum & Chemical Sales, Inc., Department PD-1, 919 N. Michigan Ave., Chicago 11, Ill.

NO. 27

## THE USE OF ADHESIVES IN FABRICATING ALUMINUM PRODUCTS

**LOW COST, VERSATILITY, EASY APPLICATION AND GOOD PHYSICAL AND CHEMICAL PROPERTIES ARE AMONG THE ADVANTAGES OF USING ADHESIVE BONDINGS IN FABRICATING ALUMINUM PRODUCTS.**

ALTHOUGH most proprietary adhesives are compounded for specific bonding jobs where certain properties are necessary, they are generally composed of the types listed in Table I. As the table shows, there are many methods of bonding, plus a variety of curing schedules. This versatility of adhesive bonding techniques and joints is the reason for their rapidly expanding use with aluminum. The simplicity of adhesive bonding has also contributed to this success. And the low cost of adhesives has helped them to gain access to jobs formerly held only by solders.

### Design Considerations

Design possibilities with adhesively bonded aluminum structures are limited only by extremes of stress, temperature and corrosive environment. Through the use of adhesives, aluminum can be joined to many different materials in one operation.

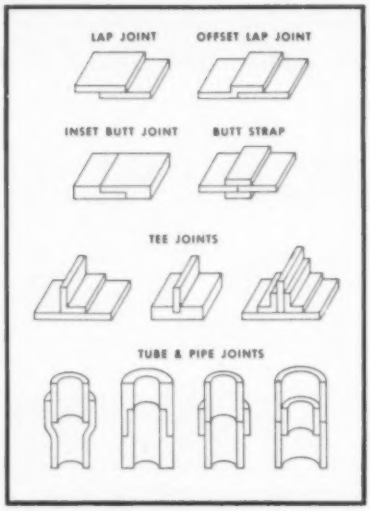
There is only one special consideration in designing for the use of adhesives in joining aluminum; peeling stresses should be kept as low as possible. In some cases it may not be possible to avoid them, but proper joint design will reduce them greatly, thereby assuring a long service life. Figure 1 shows how joints may be designed to minimize peeling stresses which might otherwise exceed the strengths of the adhesives or the materials being joined.

### Pretreatments

The pretreatments used in adhesive bonding of aluminum are concerned only with cleaning the surface. In most cases, it is not even necessary to remove the metal's natural protective oxide coating. The cleaning treatment should be selected with joint strength requirements in mind.

For lower strength joints, the ordinary mill finish of aluminum is clean enough. Solvent degreasing to remove thin films of production and handling oils is necessary for intermediate strength joints. Where the adhesive bond must develop the greatest strength possible, a chromic-sulfuric acid dip is usually recommended as the best chemical cleaning method. When a variety of materials are to be bonded together, it may be necessary to use several different cleaning methods on the joint areas before bonding.

FIG. 1




### Methods of Applying

The adhesives themselves may be applied by any of several techniques depending upon the nature of the adhesives and the desired properties of the joint. Roller coating is particularly effective for high speed application of a thin coat of adhesive, as in the production of laminates. Various building materials are currently being adhesively laminated with aluminum foil to increase their thermal insulation properties.

For more limited areas, the adhesives may be applied by brush, blade or spray, which are the more familiar methods. However, certain adhesives are being adapted to mass production practice by their manufacturers who are turning them out in film form. This film is then cut into sheets, ribbons or special shapes which follow the contours of specific joint areas. These precut shapes are then assembled with the metal parts before curing.

### Curing

Curing processes for adhesives used in bonding aluminum vary considerably with their type and form. The length of curing time may range from three seconds to 76 hours or more depending upon the type of adhesive and whether or not heat and pressure are applied to the assembled joint. Table I shows the curing times generally used with different types of adhesives. Either heat or pressure, or both, must be used to obtain the highest bond strengths.

### Properties of Adhesive Bonds

Although adhesives have been used extensively in bonding aluminum and other metals in jewelry, electronic components and other relatively noncritical items, they can also be used where strengths in the neighborhood of 8,000 psi are required in tension or shear. Table II shows the strengths attainable with various adhesives when used to bond aluminum to aluminum. In general, adhesives are resistant to water and hydrocarbons, an important factor to the manufacturers of containers.

TABLE I

ADHESIVES COMMONLY USED IN BONDING ALUMINUM*

| Type | Usual Bonding Methods | Common Curing Time | Resistance to | | Performance in Use | | Typical Applications |
|---|---|---|---|---|---|---|---|
| | | | Water | Hydrocarbons | Structural | Non-Structural | |
| Polyvinyl Acetates | Solvent Release<br>Water Evaporation<br>Reactivation | At 250°F–350°F, 3 sec | Poor to Fair | Good to Excellent | Poor | Excellent | Aluminum to aluminum, glass, ceramics, mica, wood, cork, leather, cloths, paper and many plastic films. |
| Cellulose Nitrates | Solvent Release | At room temp. 90 min–24 hr | Excellent | Excellent | | Good | Aluminum to aluminum, glass, wood, leather, cloths, thermoplastic resins, etc. |
| Natural Rubbers | Solvent Release<br>Pressure<br>Vulcanization<br>Water Evaporation | Room temp. 24 hr, 260°F–350°F, 10–30 min | Excellent | Poor | Poor | Excellent | Aluminum to aluminum, tile, glass, wood and metal attachments. |
| Synthetic Rubbers | Solvent Release<br>Pressure<br>Vulcanization<br>Water Evaporation | Room temp. 24 hr, 260°F–350°F, 5–30 min | Excellent | Poor to Good | Poor | Excellent | Aluminum to rubbers, fabrics, foils, plastics, etc. |
| Alkyds | Contact Pressure at room temp. | 10 min–24 hr | Excellent | Excellent | Fair | Excellent | Aluminum laminations and as sealer. |
| Epoxys | Catalyst<br>Heat<br>Contact Pressure | 12–76 hr<br>10 min–24 hr | Excellent | Excellent | Excellent | Excellent | Aluminum to aluminum, glass, ceramics, many plastics, cyclized rubbers and wood. |
| Phenolics | Heat and Pressure | 5–10 min | Excellent | Excellent | Good | Excellent | Aluminum to aluminum, wood and glass. Adhesive modifiers. |
| Phenolic-vinyl | Heat and Pressure | 5–45 min | Excellent | Excellent | Excellent | Excellent | Aluminum to aluminum and wood. |
| Phenolic-polyvinyl butyral | Heat and Pressure | 5–45 min | Excellent | Excellent | Good | Excellent | Aluminum to aluminum, wood, synthetic rubber and plastics. |
| Phenolic-polyvinyl formal | Heat and Pressure | 5–45 min | Excellent | Excellent | Excellent | Excellent | Aluminum to aluminum and wood (aircraft construction). |
| Phenolic-Neoprene | Heat and Pressure | 15–30 min | Excellent | Excellent | Excellent | Excellent | Aluminum to aluminum, wood and many plastics. |
| Phenolic-Buna-N | Heat and Pressure | 15–30 min | Excellent | Excellent | Excellent | Excellent | Aluminum to aluminum, brake linings and electrical assemblies. |

*Many proprietary adhesives are formulations consisting of a number of basic resin types compounded to achieve specific properties for a specific application.

Some of them offer great resistance to impact in shear, while others maintain their strengths at temperatures higher than 400°F.

## Cost Advantages

Today, adhesives range in price from thirty-five cents to five dollars per pound. The lower priced adhesives are the type most generally used in making laminates, the more expensive types for seam bonding. Because adhesives are applied at eight to nine pounds per 1000 square feet, the most expensive adhesive bond costs only one-third the price of an equivalent soldered joint.

For further information and assistance in design or application of adhesives to aluminum, contact the Kaiser Aluminum sales office listed in your telephone directory. Kaiser Aluminum & Chemical Sales, Inc., *General Sales Office*, Palmolive Bldg., Chicago 11, Illinois; *Executive Office*, Kaiser Bldg., Oakland 12, California.

TABLE II

STRENGTH RANGE OF ADHESIVE BONDS
Aluminum to Aluminum

| Type | Typical Cure Schedule | Approx. Tensile-Shear Al to Al Bonds, psi | Specific Application |
|---|---|---|---|
| Natural and Synthetic Rubbers | Pre dry 1 hr/150°F<br>5 min/300°F/300 psi | 1,150 | Aluminum name plates to appliances. |
| Polyvinyl Acetates | Solvent Release:<br>230–250°F 5–10 min<br>350°F ½–2 sec | 1,500 | Aluminum sheet and foil to masonite.<br>Aluminum foil to paper. |
| Phenolic Blends | 60 min at 350°F and 150 psi | 4,200 | Aircraft structures. |
| Epoxys | 2 hr at 150°F<br>10 min at 300°F | 6,000 to 8,000 | Honeycomb Sandwich and aircraft structures. |

see our catalog in PRODUCT DESIGN FILE or write for copy

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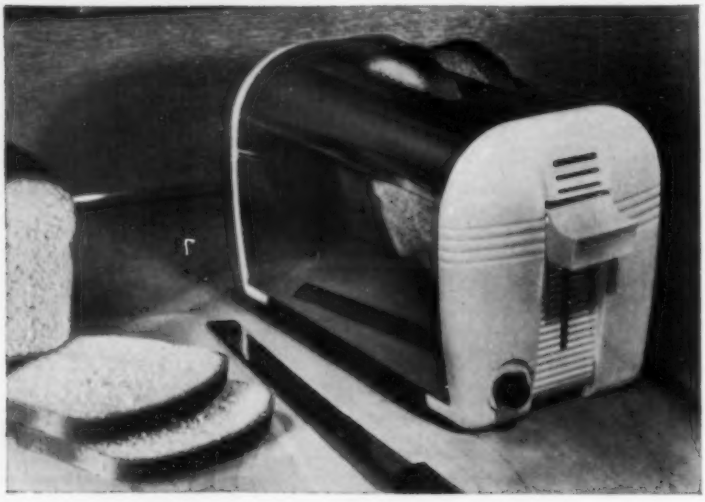
# PLASTICS NEWSFRONT



## Breakfast Brightener is Good Insulator

This colorful toaster's pastel-toned ends, panels, base and control lever, molded of BEETLE® urea plastic, will brighten any kitchen or breakfast nook. With the smart luxury look, BEETLE brings practical advantages of insulation against heat and electricity, resistance to scratching and discoloring, and easy damp-cloth cleaning. The toaster and a grill with matching handles of BEETLE are made by Capitol Products Co., Winsted, Conn.

## Solves pH Meter Housing Problem

Housings for Pocket Model and Zer-o-Matic* Bench Model pH meters must be tough, strong, impervious to chemicals and corrosion-resistant. Beckman Instruments, Inc., chose CYMEL® 1077 melamine molding compound. This tough, break-resistant plastic protects the delicate mechanism, provides color that cannot wear or chip off and eliminates use of metal subject to corrosive attack.

**Trademark Beckman Instruments, Inc.*

## No heat problem for flash unit

The new Anscoflash Type IV holder and battery case, molded of CYMAC® 201 methylstyrene-acrylonitrile compound, remain dimensionally stable under heat, thus assure tight fit for all parts and good electrical contact. The CYMAC 201 holder is tough, resistant to perspiration and staining, and is itself a good insulator. CYMAC molding compounds are available in a rainbow of brilliant and pastel colors.

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# PERSPECTIVES

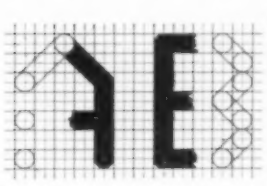
## in design and development . . .

### *On Standardizing Type Fonts*

More and more, man's reading will be done for him by machines. But this is to save time and manpower in business; by no stretch of the imagination should we expect to have our favorite western or who-dunnit devoured by a machine—with the name of the murderer ticking out on a printed tape.

The automatic handling of information, particularly in office work, is rapidly becoming a necessity. Machines have long been able to put printed information on paper. We now need machines to read and absorb this same information. But this brings up a problem in standardization: Can a standardized type font be adopted for these information machines? If so, what kind, and what is to be gained by it? And—what are the chances of all US firms cooperating to select a type face that is completely unoriginal, perhaps aesthetically unattractive, and identical with that of the shop around the corner, in the next town, and the next?

Most reading machines now being developed can read, perhaps, any one reasonably faced font. Still others, more expensive and complicated, can read several fonts, but not without resetting each time a different font comes up. The machine that will read, at a high rate of speed, several different fonts as the information is sent through it at random, has yet to be designed. The odds are that such a development remains a number of years away, and even then will not be within the range of many prospective users' pocketbooks.



A B C D E F G H I J
K L M N O P Q R S T
U V W X Y Z
1 2 3 4 5 6 7 8 9 0
. , $ ¢ & ?

The type font suggested for standardization (above) is in use on many business machines, and is based on the 5 x 7 element grid. The characters are generated by inscribing circles in any of the 35 squares and drawing tangent lines to the desired circles. Shape of the characters is like that produced by pressing selected wires or pins of a cluster of 35 through an inked ribbon against a piece of paper. Jack Rabinow, president of Rabinow Engineering Co., Inc., Washington, D. C., who suggested adoption of this font, says, "It contains the fewest elements and still makes a reasonable looking font. In fact, you might consider this font a 35-bit code rather than a printed font."

### *Who Should Use It?*

Banking institutions could have standardized by adopting this font for all important parts of a blank check. They could also have recommended that all checkwriting machinery adopt this font so checks could be processed immediately when they reach a bank, or in the user's own personal accounting department. "The current magnetic-ink systems," says Rabinow, "require retyping all checks after they reach the bank. If banks were to issue free checkwriters with various degrees of sophistication, depending

*(Continued on page 77)*

# Why V-belts reinforced with DACRON give versatility in design, economy in maintenance

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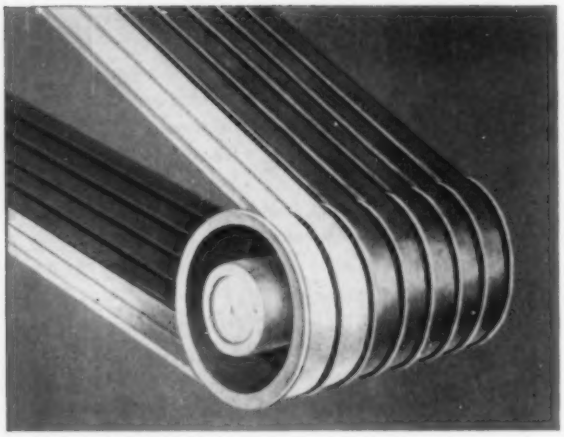
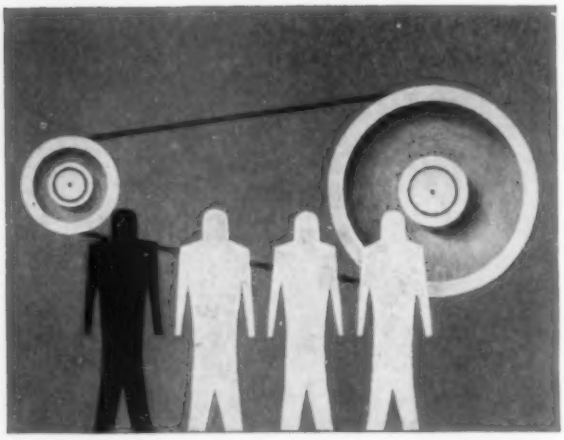
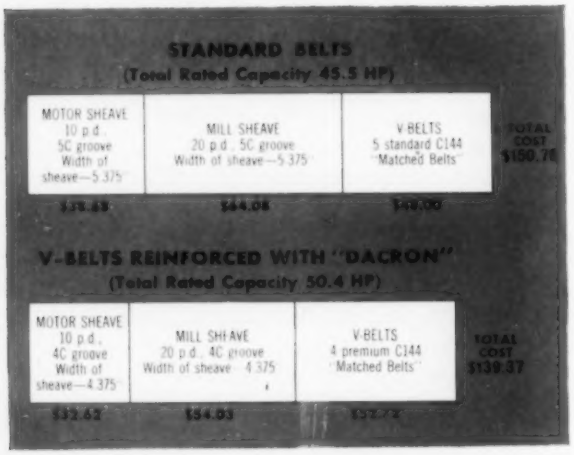


**SPACE-SAVING DESIGN.** The extra strength of V-belts reinforced with Du Pont "Dacron"* polyester fiber satisfies the demand for more compact, more economical belt drives. Designers find that fewer and smaller belts and sheaves can carry the load. In a typical case, 5 belts made with "Dacron" did the work of 7 conventional belts.



**LESS MAINTENANCE.** Stronger, longer-wearing V-belts reinforced with "Dacron" are made to operate continuously under severe shock loads without costly maintenance expense. They stretch less, have longer flex life . . . eliminate the excessive cost of frequent downtime for belt adjustment . . . a big saving in operating expense.




**LOWER DRIVE COST.** Compare cost and capacity of V-belts reinforced with "Dacron" against standard belts. You'll find that belts made with "Dacron" have increased horsepower capacity, give lower initial drive cost, easier upkeep . . . in every way a far greater dollar-for dollar value.

**"Lasted 52 times longer** than regular V-belts," reports a user of belts made with "Dacron". Despite continuous rugged use, only one belt change was necessary in five years' operation. "Dacron" yields slightly under high impact—but resists stretch. And the low moisture regain of "Dacron" —only 0.4%—assures dimensional stability to changes in humidity . . . less time spent in matching belts.

For the next drive you design or install, consider the advantages of V-belts made with "Dacron". Du Pont makes the "Dacron" used by belt manufacturers in producing their finest-quality V-belts. E. I. du Pont de Nemours & Co. (Inc.), Textile Fibers Department, Wilmington 98, Delaware.

*"Dacron" is Du Pont's registered trademark for its polyester fiber.

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

**V-BELTS OF "DACRON"** transmit more horsepower . . . stand greater shock loads . . . give longer flex life . . . give greater opportunities for machine-design improvement.

on customers' needs, cost of the checkwriters would be more than offset by the possible savings resulting to the bank.

Another big use for standard fonts would be where the material is specifically designed for business machine use, such as paychecks from certain automatic machines where verification is necessary between the printed and the punched data. In some cases, humans are now used.

Several reading-machine designers predict that, in the long run, punched cards will be eliminated—reading machines will take over the job.

In general bookkeeping, which requires many forms for tabulating by automatic machines, a standard font should be very useful because standard reading machines could then handle forms at the receiving end of the operation. Why not make it just as easy for the person receiving a standard-type-font order as it is for the company sending it?

Also, what about household bills, and those from various stores? When these are paid by check, the bills and the checks printed with identical type fonts could be read together by machine.

And think of the large-scale bookkeeping operations of both government and industry. In the Social Security and income tax bureaus alone, many million entries must be transcribed from typewritten or business machine forms to punched cards; then the information must be entered into extensive records. Each year the US government and industry issues billions of checks which must be proofread, sorted, tabulated, canceled and verified back into the original records. With a standard font, and a standard check size, such check processing could be made completely automatic.

## *The Big Payoff*

Automatic post office machinery has been designed and is now being built. Here the standard font will really pay off. If the large users of mail, such as big insurance companies, mail order houses, publishing houses, the Government, advertisers, go to a standard font, the post office, which usually gets this mail in separate deliveries, could process it without human intervention. Standardizing a business font just for the benefit of post office operations would pay by increasing that department's efficiency. Also, most post office errors today are human, and while machines too can make mistakes, self-checking systems could be easily added.

To get the program moving, users of the standardized font could be given preferential handling of the mail, plus a postal rate lowered by ¼¢ to ½¢. For companies with huge quantities of outgoing mail, the change to a standard form of address, standard abbreviations, and standard font would be a saving. The post office could save double that amount.

The standard font could be particularly useful in transmission of teletype and telegraph messages and in the printed output of high-speed computers. The messages are often retransmitted, and the standard font would allow reproducing them, as any other code, without deterioration of quality.

## *The Cost to Change*

Changing the type font on the millions of typewriters would be relatively inexpensive. As for the long lists of addressing plates already in existence, changes in the lists occur often enough so that in a year or two most lists would undergo a complete revision anyway. Linotype machines also could be adopted to any type font desired.

However, to completely automatize the post office there is the problem of developing machinery to read handwritten addresses, which constitutes a fair proportion of the total mail bulk. Bell Labs recently developed a system for reading handwritten numbers which requires the writer to conform to a certain writing style. But the system must still be adopted to letters as well as numbers. —Paul Anderson

# 6 SPEED NUTS® replace 10 fasteners ...and costs drop 80%!

Six Tinnerman SPEED NUTS replaced 10 weld nuts on the Gibson Window Air Conditioner... and production costs dropped more than 20 cents per unit!

Working with the designers at Gibson Refrigerator Company, Division of Hupp Corporation, Tinnerman engineers suggested using four "J" Type SPEED NUTS to fasten the front panel to the air conditioner cabinet. These one-piece, self-locking, spring-steel fasteners snap in place by hand; are self-retained in screw-receiving position. They also used two Flat Type SPEED NUTS to fasten the window mounting channel to the cabinet.

By eliminating ten weld nuts, Gibson was able to divert a spot welding machine to other uses, reduce materials handling, simplify and speed up assembly. They cut costs right down the line — without sacrifice of product quality!

Savings like this are being made every day when manufacturers switch from ordinary fasteners to Tinnerman SPEED NUT Brand Fasteners. Over 9000 variations are available to handle practically any fastening job, from tiny transistors to huge freight cars.

Send for complete data on how you can make important assembly-cost savings. And investigate the possibilities of having a Tinnerman Fastening Analysis made of your products. Call your Tinnerman representative, or write to:

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**Product Engineering** HORIZONS

April 28, 1958

# THE RED ROCKETS' GLARE

Reaction to the sputniks, initially almost hysterical, is now expressed in much more substantial terms in the United States. Planned expenditures on research and development for 1958 have jumped 14% over those for 1957, in the face of a 12% decline in plans for capital spending, according to the latest survey by the McGraw-Hill Department of Economics (*PE*—Apr. 21, p. 21). This raises the 1957 total of $7.3-billion to $8.3-billion for 1958; a further rise to $9.85-billion is already anticipated for 1961.

The largest gains in R & D (also 14%) are in the manufacturing industries ($7.95-billion in 1958), but the lion's share is of course in aircraft and parts plants, where the rise is 36% (2.3-billion to $3.2-billion since last year). For comparison, expenditures in electrical-equipment (including electronics) and fabricated-metals plants (including ordnance) are up only 7%, in machinery plants only 5%.

The survey goes on to study what we expect to get from money going in. These results suggest that the expenditures are *not* primarily for basic research, but for *applied* research and for *military* and *commercial* development—our traditionally strongest areas of activity.

For example, 48% of the companies queried say the funds are being invested for new products, another 41% say to improve old ones, and 11% expect new processes. The emphasis on new products is highest among electrical-machinery makers (68%) non-ferrous metal producers (64%) and aircraft plants (56%).

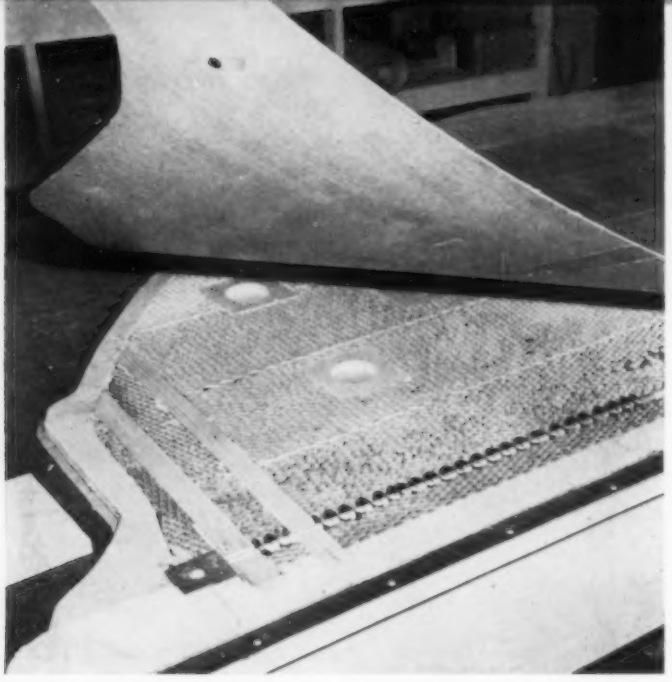
Some 39% of the repliers expect the program to pay out in less than three years, another 52% in three to five years. This indicates the programs in general are fairly well along, if the average seven-year development program (*PE—Sept.* 21, '57, p. 32) is attained.

Corroboration is also provided by the answers to the question, "How much of your 1961 sales will be in new products?" The over-all answer is 12%, but in aircraft it rises to 42%, in machinery to 22%, in non-machinery and non-transportation equipment to 13%.

These figures are surprising and very heartening in the face of declines in sales volume. They show industry is firmly committed to a policy of new products as the source of increased sales. And we are apparently within a year or two of the flood of results from burgeoning R & D programs of the past six years. Our economist predicts that America will then have "new products coming out of our ears"—most of them begun well before the Red rockets' glare.

It is important, however, to realize that money is not the whole answer. We need also to change our way of thinking, to realize that we must encourage more creativeness, more originality in ideas. We must learn to single out and utilize gifted people, to support them in what they try to do. They may need only a garret and a few tools—if they are also given real understanding and the opportunity to work undisturbed by deadliness or dollar shortages.

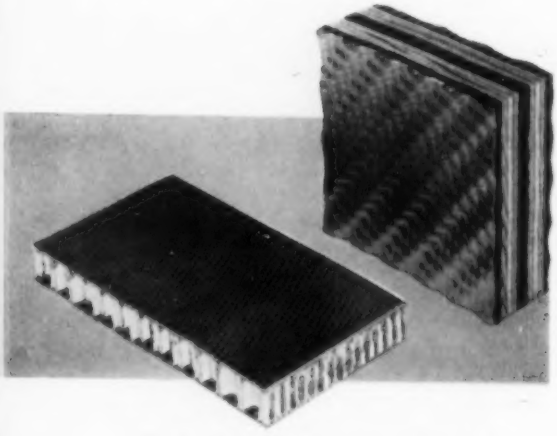
L. J. Haugeman



selection guide for

# sandwich-panel FACING

**This second of three articles on modern industrial sandwich structures describes materials that make the skins. First article *(PE-Jan. 20, p. 70)* similarly gave advantages and disadvantages of core materials. Next article will tell which adhesive to use.**



**Protection against marring . . .**
is provided by facing with textured metal. Left: aluminum gives honeycomb core and facings for aircraft decking. Right: supermarket door, developed by Rigidized Metals Corp., has stainless steel bonded to plywood, with interleaving of foam rubber to take shock.

In sandwich construction almost any sheet material will work as a facing. Most of them have been tried at one time or another in the search to meet requirements of strength, weight, stiffness and maintenance. Which material to select goes beyond just examining the facing itself. As a structural composite, the completed sandwich gets its good or bad characteristics from all three components —core, facing and adhesive. So, for example, a stainless steel skin might require a rigid core like foamed glass or asbestos cement board. This is because the steel should be thin as possible to keep costs down–but light-gage sheet is easily dented in service.

Wood in various forms was long the main material for facing panels. But now a list of common facings includes: metals–carbon steel, stainless, aluminum, copper, magnesium; plastics–especially the fiber-reinforced types; and some nonmetal inorganics, such as asbestos cement board.

The panels may be flat—or textured (*PE*—Mar. 17, '48, p. 73) to improve appearance and ease thermal stresses. Although color problems may dictate facing material, they seldom influence structural design—an exception being porcelain coating on metal facings, which gives up to 50% added rigidity.

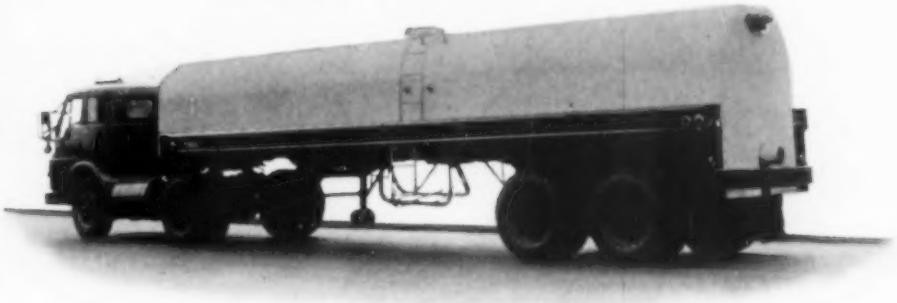
## THE METALS

Because metals provide high strength to resist beam stresses, very thin sheets will work. But this raises three problems:

- **Slight thermal buckling,** particularly in large areas, often produces a wavy surface objectionable to the eye. This can be corrected by using a more rigid core, backing the sheet with a secondary facing of plywood, embedding stiffeners in the core, or by texturing the metal.
- **Impact loads need stiffness** in the facing so they will be distributed over the core area. For this kind of loading, sheets will need secondary facing.
- **Thin sheets also buckle easily,** so thermal coefficients of expan-

**Aluminum facings . . .**
plus paper honeycomb give lightweight strength to aircraft partition.

**Milk, and sandwich construction . . .**
go together in this Heil Co. dairy tanker with reinforced plastic outer body, foamed plastic core, and stainless inner tank—bonded together in one-shot molding.



# MATERIALS

**R. K. HUMKE**
*Mgr., Technical Service Lab.*
*Adhesives, Coatings & Sealers Div., Minnesota Mining and Mfg. Co.*

**From railroad . . .**
this Pullman-Standard meat locker is relayed to tractor trailer. Epoxy-glass laminate facing takes abuse, stiffens and protects balsa core.

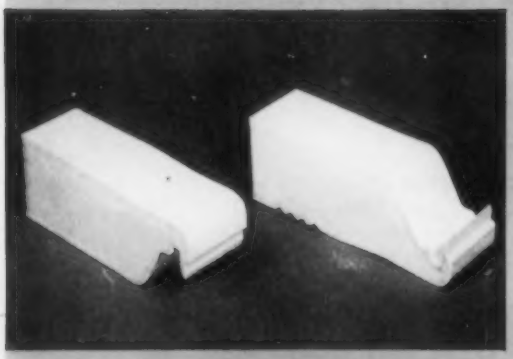
sion of the two facings must be balanced; otherwise faster shrinking on one side will produce distortion of the other.

Here are the metals commonly selected for facings, and the properties in their favor:

**Stainless steel,** though a high-cost facing material initially, becomes economical when its strength and corrosion resistance over a wide range of temperatures are needed. The sandwiches are better when the stainless is laminated directly to the core, rather than to a secondary facing (for retention of flatness). This is why rigid cores are best–for example, balsawood in milk trucks, foamed plastics in curtain walls, and stainless honeycomb in advanced supersonic aircraft. New coloring methods for stainless are pushing this facing material into expanding consumer markets where eye appeal is important. Construction methods include adhesive bonding, furnace brazing and welding.

**Carbon steel** facings must be protected from corrosion for long sandwich-panel life. The most common methods are painting before or after forming (*PE—Dec. 9, '57, p. 99*), porcelain coating (*PE—Feb. 17, '58, p. 75*), and galvanizing. Less common are vacuum metallizing, and laminating with vinyl or polyester films. Porcelain is the most durable of these, but requires the facing to be completely shaped before coating. Most common design error with porcelain-coated facings is specifying too light a gage. If the core is at all flexible, hairline cracks and chipping can easily occur in the coating.

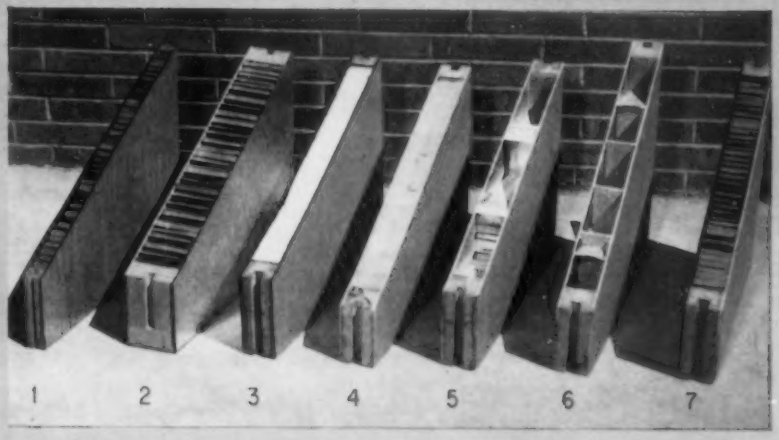
**Aluminum** as a facing for wood cores like balsa and plywood has helped solve critical weight problems for many years–in truck bodies and trailers, for example. Aluminum honeycomb cores with aluminum skins joined by brazing or structural adhesives are fairly common in aircraft structures. Key properties are high strength-weight ratio and excellent corrosion resistance. Main problem is the lower elastic modulus which makes buckling and denting easy unless a rigid core provides backup. Some aluminum facings are



**Post-formed facings . . .**
of polystyrene sheet are teamed with foam-in-place urethanes to give shaped panels for German refrigerator.

**Open-faced sandwich . . .**
for auto-heater housing uses foamed urethane for thermal insulation and single facing of molded plastic for shape and rigidity.

**Thin aluminum . . .**
backed by rigid secondary facing, decorates and protects experimental panels built by National Homes Corp. Interior partition (1) has melamine plastic finish and paper honeycomb. Other panels are load-bearing: (2) roof-ceiling uses hardboard stiffening and paper core, (3) expanded polystyrene with hardboard backup, (4) glass fiber core and asbestos cement backup, (5) gypsum grid core with asbestos cement secondary facing, (6) asbestos cement grid core and backup, and (7) impregnated paper honeycomb core with outside backup of asbestos cement, inside backup of hardboard.



**Cobalt-base alloy . . .**
sandwich developed by Solar Aircraft Co. withstands 10,000-psi skin stress in cantilevered loading test at 1500 F for 2½ days. Core is square honeycomb made of Haynes alloy No. 25 foil 0.002 in. thick; facings are heavier gage sheets brazed to core.

COMPARISON—PROPERTIES OF FACING MATERIALS

| Material | Specific Gravity | Thermal Expansion, in./in./F x $10^{-6}$ | Tensile Strength, psi x 1000 | Flexure Strength, psi x 1000 | Elastic Modulus, psi x $10^{6}$ |
|---|---|---|---|---|---|
| Carbon steel | 7.9 | 6.5 | 60[b] | ..... | 30 |
| Stainless steel | 8.0 | 5.1-8.0 | 75-110[b] | ..... | 29 |
| Aluminum | 2.7 | 13.0 | 16-42[b] | ..... | 10 |
| Reinforced plastics (glass fabric) | 1.5-2.1 | 0.1-0.5 | 10-50 | 10-80 | 1.0-3.5 |
| Woods | 0.5-1.2 | 1.1-3.6[a] | ..... | 9-18 | 1.2-2.0[c] |

[a] Along grain. Across grain: 14.6-34.1
[b] Annealed
[c] In bending

extruded, particularly where the facing is designed for interlocking with other panels after bonding.

Foamed plastic cores have given impetus to aluminum facings in sandwich construction. Under development is a new technique of continuously expanding polystyrene beads between facings of coiled stock. The panels are cut to length as the composite emerges, much like production of extrusions. When formable anodized and porcelain-type color coatings for aluminum sheet pass the development stage, such panels will be able to be shaped into structures for refrigerators, air conditioners, food coolers and the like by such techniques as the Westinghouse fold-up method.

Where post-forming is unnecessary, there are well-established coloring and texturing methods suitable for aluminum sandwich facings (*PE—Sept.* 30, '58, *p.* 101). Prefabricated wall panels—for homes and small portable industrial buildings, for example–are now available with aluminum foil-coated paper honeycomb cores, and foamed plastic cores are beginning to move into this field too.

## THE PLASTICS

**Glass-reinforced plastics**–polyesters, epoxies, phenolics, and silicones–offer high strength-weight ratios for facings, also corrosion resistance and good dielectric properties. As reliability standards for reinforced plastics become established (*PE—Feb.* 3, '58, *p.* 69), plastic laminate facings will become more common. With paper honeycomb cores, panels for truck bodies, tanks, boat decks, and radar housings have already been built. Cores of foamed plastic—urethanes and polystyrenes, for example—work well with laminated plastic faces because the lay-up process tightly locks facing to core. With contoured parts, these facings are easy to apply by hand lay-up. A newly developed technique (*PE—Jan.* 13, '58, *p.* 17) uses a specially designed spray gun to apply resin, roving and catalyst simultaneously–and the process may soon be adapted to mechanized sandwich panel construction.

**Non-reinforced** thermoplastic sheet material is often post-formed to give panels of unusual cross-section–even hollow shapes like housing and radomes–when combined with foam-in-place cores like the urethanes, polystyrenes, and vinyls. Chief advantage of these composites is light weight, good insulation, and buoyancy.

## THE SOLID WOODS

Wood offers availability, low cost, light weight, and ease of shaping. These advantages are offset by problems of rot, moisture absorption, flammability, and insect attack. Woods vary in resistance to these influences, and special preservatives like coal-tar creosote and zinc chloride–as well as fire-inhibiting chemicals–help too. Sandwiches are put together with structural adhesives and such core materials as paper honeycomb, plywood, and plasterboard. Packing cases, pallets, and small transportable buildings have been made with paper cores. Such utility applications employ softwood facings–fir, pine, spruce. Hardwoods, because of cost and greater finishing difficulty, are reserved for decorative applications. Here are the five most familiar hardwood facings:

- **Mahogany** is dimensionally stable in use, resists dry rot, insects, and worms. Colored from light to deep reddish brown, it is easily worked and finishes to a high luster.
- **Walnut** resists warping best of all hardwoods–important because warping applies additional stresses to adhesive bond and core.
- **Oak** is available in the US in about 60 species, though only two–red and white–are important panel materials. White oak is the more durable because of close pore structure which resists moisture permeation.
- **Maples** are fine-grained, and wear smooth without forming splinters. Two hard grades most common as facing are sugar maple and black maple.
- **Gumwoods** lie between the preceding hardwoods and the utility softwoods in hardness, are close-grained and take a high polish, but are not particularly weather-resistant.

Facings with the decorative appearance of hardwood and the durability of plastic or metal are also possible with the many established lithographing techniques.

## THE PROCESSED WOODS

Special processing can overcome some of the natural disadvantages of solid wood, particularly the native graininess that gives a tendency to warp and split in use.

**Plywood** is an adhesive-bonded laminate of an odd number of sheets, with grain criss-crossed, of solid wood. **Impregnating wood** with synthetic resins like phenol formaldehyde, urea, or methyolurea increases moisture resistance, thereby reducing swelling and warping. **Compressing wood** at elevated temperatures creates a natural impregnating agent from its lignin and improves moisture resistance, as well as increasing density. **Impregnating plus compressing** seals wood from moisture penetration, improves abrasion and chemical resistance, but decreases toughness. **Hardboard,** a more dense product, is made by exploding the natural fibers of the wood and compressing them into sheets. In standard hardboard, the natural lignin is the bonding agent; in tempered hardboard, a phenolic resin is used for greater moisture resistance. All the processed woods have been used for both facings and cores, and are commonly applied as secondary backup for light-gage metal facings.

In addition to elimination of grain rise and checking –properties and dimensions of processed woods can be controlled to panel design requirements. They are inexpensive, machined easily, and produced in larger areas than is possible with solid woods.

## THE INORGANIC NONMETALS

Asbestos cement board is the most common, and its nonflammable characteristic makes it an ideal facing for firewalls. Small buildings have been constructed of panel faced with this material–the core is paper honeycomb impregnated with a cement slurry for fire resistance. Moisture resistance is excellent, and the board can be worked like wood although tool wear is high. Chief disadvantage is high density–up to 80 lb per cu ft.

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# Casting Alloy Enters High-strength Field

**This special steel offers advantages in cost and easier fabrication. Here are its properties, and design tips.**

**E. G. OPSAHL and W. H. SPARING,** *Product Engineering Department, American Steel Foundries*

It proved its wear resistance in the mining equipment field. And now the casting alloy called Wearpact is going into applications where its high strength challenges forgings. It is a cost-cutter too–because it can be cast to complicated shapes, minimizing need for machining or other fabrication steps that can lead to trouble. Additional advantages are high hardness without brittleness; low notch sensitivity in fatigue; dimensional stability.

The material is the first commercial high-strength casting alloy. It is made by adding boron and rare earths to a low-alloy steel. This gives ductility at 500 BHN and deep hardenability in sections up to 4 in. thick. With slightly higher percentages of the other, usual additives, hardenability increases up to 8 in.

The material is also unique because heat treatment can give a differential hardness–with relatively soft center sections–allowing bores to be machined easily.

**Tensile properties** at the recommended hardness, 477 to 534 BHN, are given in the following table. Minimum guaranteed properties are: ultimate tensile strength, 220,000 psi; yield strength, 180,000 psi. Notched tensile properties are similar to those of other high-strength steels but Wearpact shows greater ductility with three times' higher reduction in area.

**Strength Comparison of Steels**

| Material | Ultimate Strength, psi | Yield Strength, psi | Fatigue Strength | |
|---|---|---|---|---|
| | | | Standard, psi | Notched, psi |
| SAE 4340.... | 240,000 | 220,000 | 70,000 | 40,000 |
| Wearpact... | 240,000 | 195,000 | 73,000 | 53,000 |

**Impact strength** is high even when these steels are hardened completely through their cross-section. Room-temperature Charpy V notch impact strength–about 20 ft-lb–is at least 25% higher than that of other steels at the same hardness. The material retains good impact properties well below the transition temperatures of other ferritic steels (−40 F) and shows good impact properties even as low as −250 F.

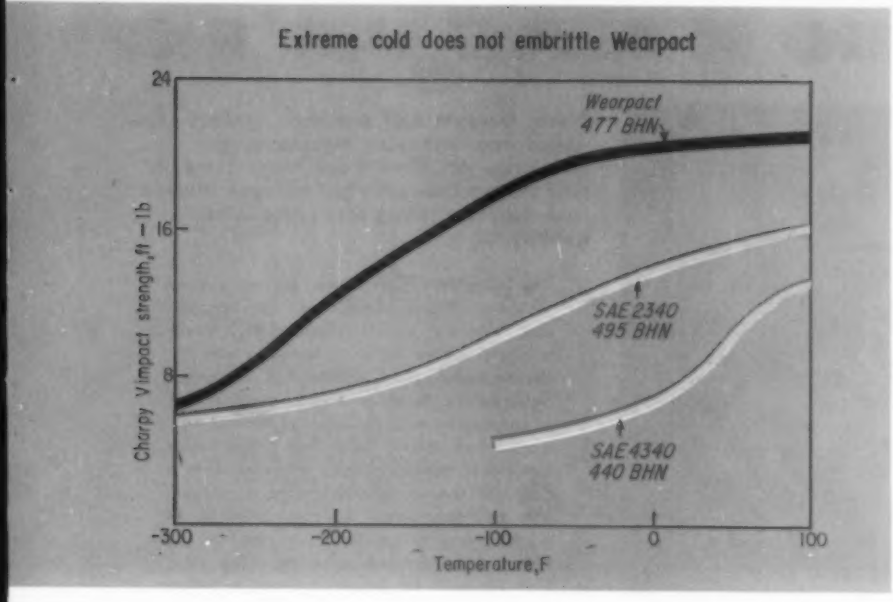
**Low notch sensitivity** in fatigue is shown in the table. Fatigue strengths, both standard and notched, are greater than those of 4130 brought to the same hardness. Values in the table are given for machined and polished specimens. In practice, however, a casting may have somewhat different values–sometimes these are slightly better because castings have larger as-cast radii and more gradual section changes. These lower stress concentration. Foundry cleaning procedures such as grit blasting do not add residual tensile stress, as grinding or machining do.

**Easily cast in sand,** these steels have a shrinkage similar to that of low-carbon steels. The same patterns as for low-carbon or low-alloy steels can be used without changes–giving added savings in tooling. In some cases, patterns for manganese steels can also be used despite slightly different shrinkage.

**Wear resistance** is the property that, until recently, was the alloy's main asset. Besides such wear applications as power-shovel bucket teeth, liners for ball mills and ore chutes, it is also used in large pinions and racks, tractor treads and cable sheaves, and structural parts.

**Dimensional stability** is good, especially in contrast with austenitic manganese steels–which flow with cold work, change to a hard martensite, and undergo a slight increase in dimensions. Although manganese steels have excellent resistance to wear from a pounding action they are often not suitable because the increase in dimensions jams moving parts. Unless cold-worked, these steels do not harden; and abrasive action can wear out parts quite rapidly. By contrast, the new alloy is already hardened, resists flow, does not change structurally, and therefore does not give dimensional increase which accompanies such change.

**Low temperatures** lower impact strength, but the drop is less than for other ferritic steels. From 300 to −150 F the Charpy impact strength drops from 18 ft-lb to 16 ft-lb. Austenitic stainless steels, noted for high impact strength at low temperatures–30 to 80 ft-lb–are limited because their tensile strength is about 130,000 psi. Here Wearpact shows most promise. It




combines high tensile strength at low temperatures without substantial loss in impact properties.

**Compatibility** with low-carbon steels arises from similar physical properties. The thermal coefficient of expansion, electrical resistivity, specific heat, and thermal conductivity are about the same as for low-alloy and carbon steels heat-treated to the same structure—a similarity that gives little trouble when castings are used in ordinary steel structures.

**Elevated temperatures** up to 350 F have little effect on the mechanical properties. Above this temperature, the steels soften and lose mechanical strength and hardness.

## WHEN YOU MUST FABRICATE

Machining is recommended when the material is normalized. However, good design aims at minimum machining to get the economy that comes from casting to shape. When hardened, the alloy must be machined with carbide tools. Compared with 4340 steel at 500 BHN, Wearpact is more readily machined at cutting speeds below 175 ft/min and more difficult at faster cutting speeds. At 300 BHN, tools for machining Wearpact have five times the life of tools used for machining 4340.

Parts for welding must be preheated to 150 to 330 F, and welded with stainless steel electrodes or low-alloy electrodes AWS-ASTM, Class E-7016 through E-12015. Welding reduces strength at the heat-affected zone. Parts must be weld-fabricated before hardening as rehardening is not recommended. Parts with high wear should be mechanically fastened rather than joined by welding. Usually, throw-away parts save money over rebuilding by welding.

## DESIGN POINTERS

Casting intricate internal shapes gives one-piece design without need for expensive cored forgings and welded fabrications. Limiting close tolerances to external diameters which can be machined more easily gives additional savings.

High strength-weight ratio combines with the traditional advantage of cast metals—easy distribution of metal for maximum rigidity—to give stronger, more rigid structures, lb for lb, than forgings. With economy as the primary advantage, cast steels now present new design concepts in the lightweight, high-strength structural field. Two examples are:

**Self-sharpening dipper teeth.** The greater strength of Wearpact allowed redesigning the original part with a thin, hollow-ground contour and a cap tooth design which permitted up to 80% to be worn off before replacing. The sharp teeth lowered power required for digging and also gave four times longer service life.

**Track shoes of crawler tractors.** The thinner, stronger shoes are 35% lighter in weight, while showing less wear and less distortion in service. Similarly, metal-plate conveyors can be stronger and more wear resistant.

**EDITOR'S NOTE:** Other aspects on design of high-strength structures are covered in:

"A Fresh Look at Leaded Steels," Apr 14 '58, p 72. Controlled additions of lead give high-strength steels good machinability without loss of tensile, impact and fatigue strength.

"New Aluminum Forging Alloy," Dec 23 '57, p 62. Lower notch sensitivity makes alloy 7079 better than older 7075 for thick sections requiring high strength.

"High-strength Steel Key Factor in Design of World's Largest Shovel," May '56, p 148. T-1 high-strength weldable steel doubles dipper capacity.

"Fabricating Ultrahigh-strength Steel," Dec '55, p 170. How to work SAE 4340 to assure maximum strength and reliability. Gives design tips; checklist to evaluate applications.

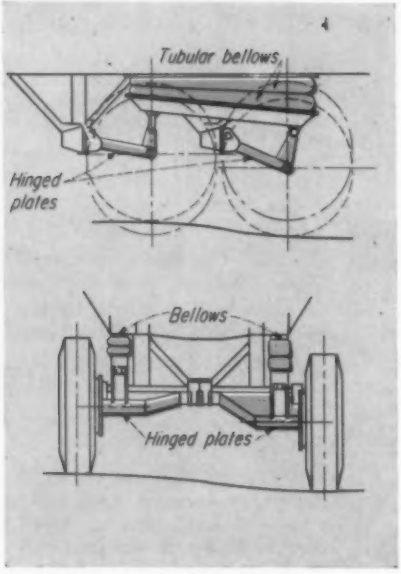
"Ultrahigh-strength Steel for Aircraft Structures," Oct '53, p 129. Gives comprehensive design properties for SAE 4340, tells how to process and fabricate it.

# DESIGN FEATURES

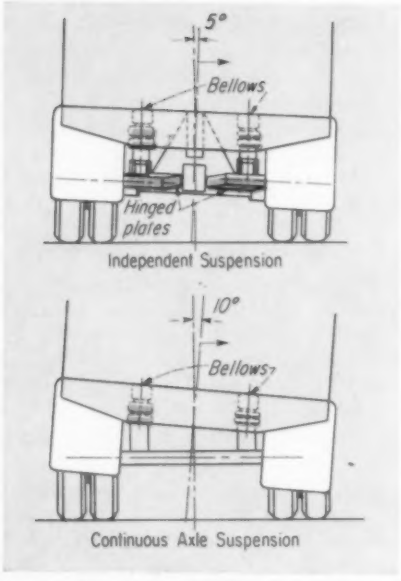
**Dutch, German and American designs show varied approaches to automotive air springing. All three have these common advantages: chassis height changes little with load; variable spring rate gives better stability.**

The Dutch system, developed by Van Doorne Automobielfabrik, Eindhoven, for tandem-axle highway trailers, supports the chassis on long rubber bellows. Nitrogen and hydraulic cylinders are combined in the system designed by Siegener Eisenbahnbedarf AG in cooperation with the German Federal Railways for an 8-axle trailer that carries heavy loads over uneven ground. American Motors Corp. of Detroit put air springs in parallel with coil springs on the rear axles of its Rambler cars to get the same ride characteristics when loaded as empty. (See *PE—Mar. 10, p. 25* for Detroit's thinking on future air spring designs.)

## 3 LOOKS AT AIR

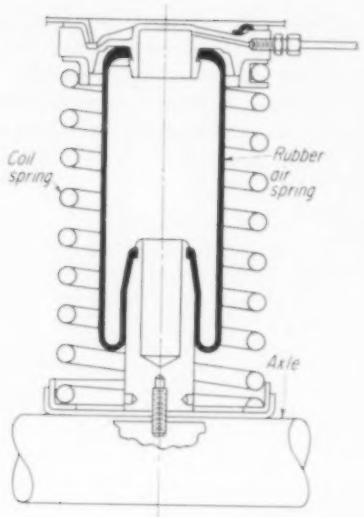



**Independent wheel suspension . . .** of Dutch trailer lets tubular air bellows distribute load evenly. Each wheel is on a stub axle fastened to a plate hinged on a crossmember that is hung beneath the chassis. Lower support for each bellows is hollow, allowing it to serve as plenum chamber. It receives air through a leveling valve. The two valves are mounted on chassis; each has a lever connected to its plenum chamber. The valves add or remove air that keeps chassis level as wheels follow road contours.

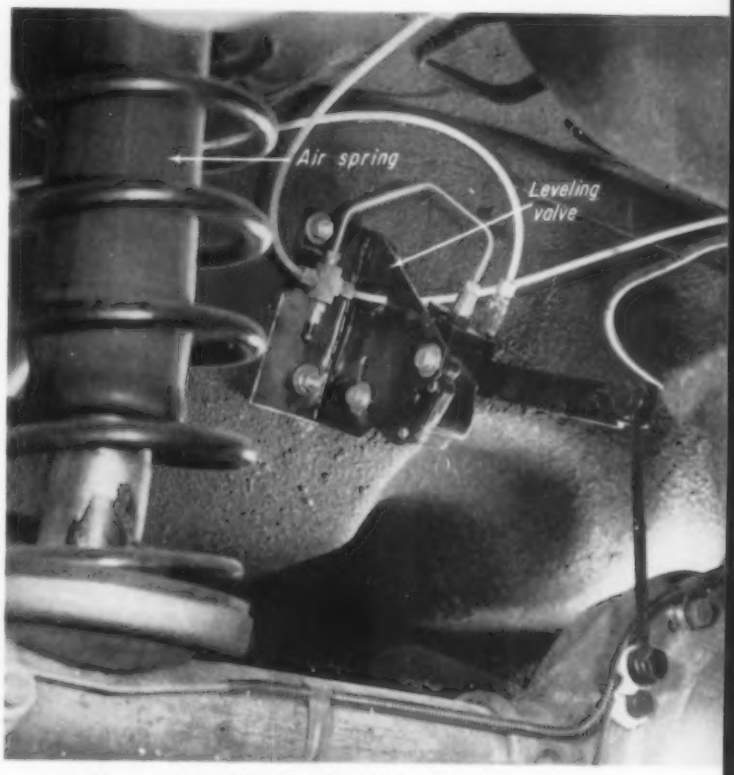



**Better lateral stability . . .** results from independent suspension for each wheel. Body tilt for a given sidewise unbalance moment is half that experienced with designs using continuous rear axles. With a continuous axle, spring deflection depends on distance from center of spring to trailer centerline; but with independent suspension, deflection depends on wheel motion relative to crossmembers (controlled by the greater distance from trailer centerline to that of wheels). This doubles the effective moment arm.

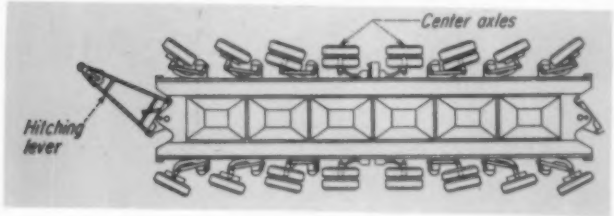
# IN NEW PRODUCTS

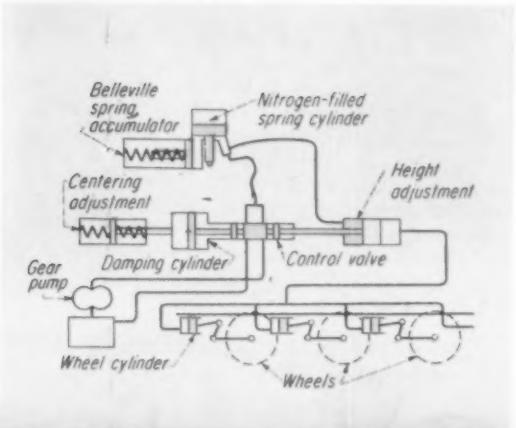



## SPRINGS




**Weight distribution . . .** in a passenger car depends on passenger load and cargo carried in the trunk. A typical American Motors' car, when empty, puts 44.5% of its weight on the rear wheels. A full load of passengers raises this figure to 50%, and trunk loads even higher. This makes the variable spring rate and the leveling action of air springs more effective on the rear wheels for keeping riding characteristics the same when empty or loaded. Combining air and coil springs lets air springs handle load changes and leveling while coil springs carry empty weight. Also, car can be operated if air supply fails. The air spring is made by Goodyear Tire and Rubber Co. Data is from paper delivered at SAE Annual Meeting, Jan., 1958, by Wallace S. Berry, American Motors' director of automotive research.




**Cranks that support wheels . . .** are connected to pistons of horizontal oil cylinders in the German design. These cylinders, in groups of 4, are connected to combination spring-and-gas-loaded accumulators that give the spring action. Coupling the cylinders on each side distributes load evenly when traveling over uneven ground.

Trailer chassis is made in two sections that can be used separately, each carrying 20 tons; a simple coupling joins them for normal operation. The chassis is made of two box girders connected at the ends by steel castings and covered with steel plates. The plates carry angle iron rails for use when railroad cars are transported. Chassis height is adjusted by pumping oil in or out of cylinders.

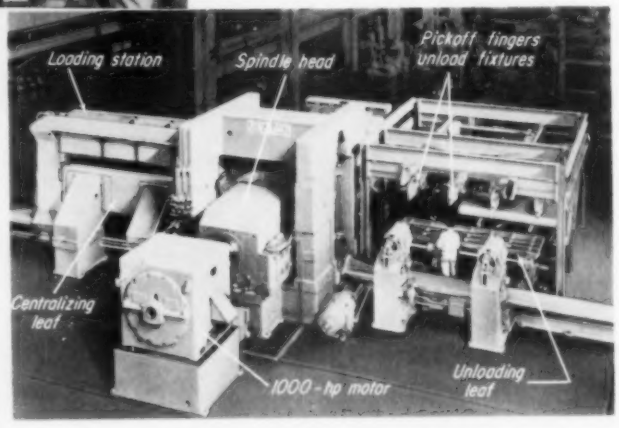
All wheels turn for steering except those on the two center axles. Hitching lever turns wheels with a control rod running the length of the trailer; a simple crank at the center coupling reverses the turning motion transmitted to rear section. The 26-ft trailer has a 20-ft turning radius.

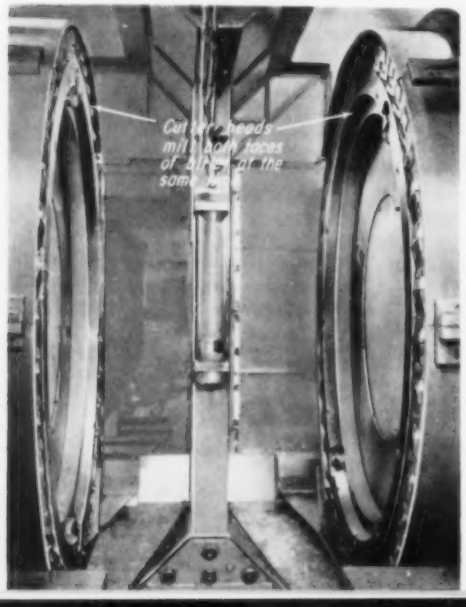
# MILLER TAKES DOUBLE SCALP

**Double-spindle method allows machine to mill both faces of an aluminum billet simulaneously. Machine works six times faster than single-spindle type, and turns out better product.**

New design ideas here in machine and cutters make possible the high production rate and low servicing costs. Miller has two 75-in. inserted-carbide facing cutters, the largest ever made. They scalp billets in 90 sec that require 10 min on single-spindle machines. The preset cutting inserts reduce blade-grinding time from weeks to hours, and setup time from hours to minutes. Machine was designed by Consolidated Machine Tool Div. of Farrel-Birmingham Co., Inc., for the Ravenswood, W. Va., plant of Kaiser Aluminum and Chemical Co. Cutters are made by the Wesson Co., and each spindle is driven by a 2300-v air-cooled motor made by General Electric.

**Billet is held . . .**
by vertical fixture that clamps its edges between hydraulically actuated bits. The rough billet is placed in the fixture by a loading leaf that tilts it on edge and carries it against a centralizing leaf, centering it over the clamps. Then the fixture is fed past the cutters by a rack-and-gear drive. First, the fixture traverses rapidly to the cutting heads and shifts into the preset feed speed. When the billet clears the cutters, the fixture traverses rapidly to the unloading station. Here, an unloading leaf tilts the billet to the horizontal position so a pickoff device can shift it to a run-out conveyor. Each spindle is driven at 600 rpm by a 1000-hp motor through a Jordan coupling.



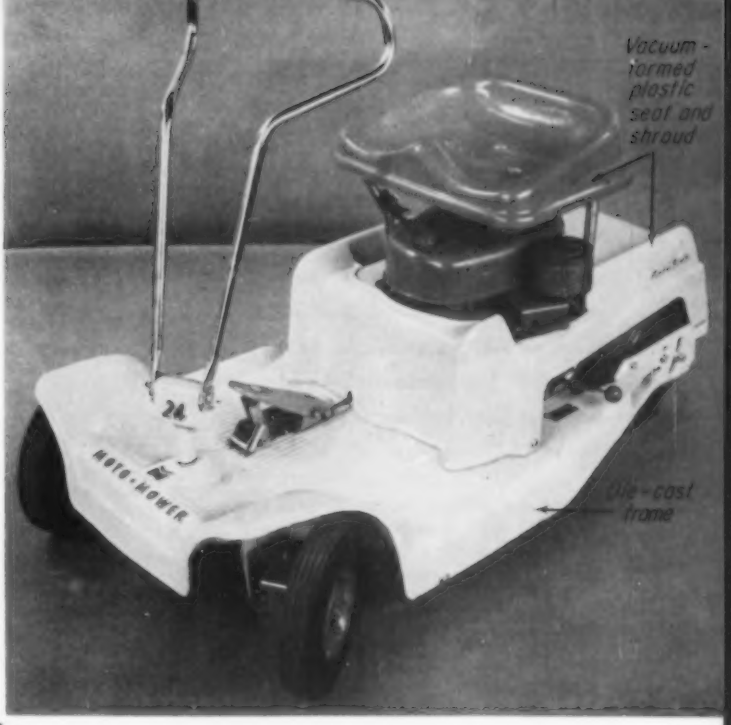



**Stock removal rate . . .**
is held at 5000 cu in. per min and chips are blown to a conveyor beneath the cutter chamber. Cutter adjustments are made independently while the motors are running, in 0.01-in. increments up to 17 in. Normally, the operator adjusts the cutters for desired depth of cut before the cycle begins. If heads are not separated enough to admit the billet, however, the fixture stops automatically. At the fixed spindle speed of 600 rpm, cutter surface speed is 11,800 sfpm. About $\frac{3}{8}$ in. of scale and scrap metal is scalped off each side of the billet. Billets processed are 8 to 16 in. thick, 30 to 54 in. wide, and 6 to 14 ft long.

# Castings Cut Mower Costs

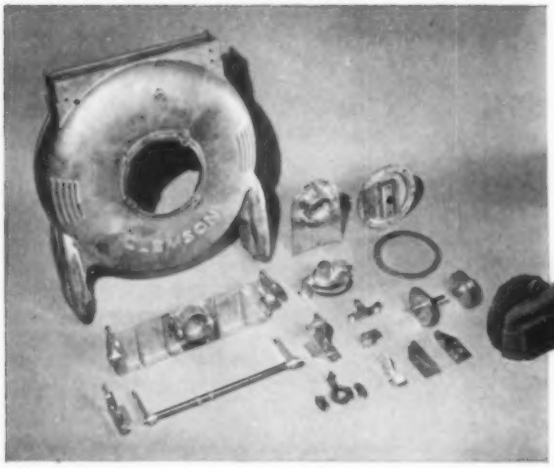
**Two manufacturers of power mowers find advantages in designing with cast parts. Cost is reduced; appearance is improved.**

Self-propelled mower made by Clemson Bros., Inc., Middletown, N. Y. and riding Motomower made by Detroit Harvester Corp., Detroit, are noteworthy for their use of cast parts. Both have cast frames and are powered by gasoline engines; Motomower has a 3½-hp Clinton engine and the Clemson a 2¾-hp Briggs & Stratton.



**Combination chassis-deck . . .** of Motomower gets required rigidity from ribs that form walls of blade housing. Advantages are low cost, light weight, ease of finishing. Only machining needed is finishing holes to mount drive and wheels; the permanent-mold casting is finished with a baked enamel. Engine shroud and seat are vacuum-formed plastic. This mower cuts a 24-in. swath.

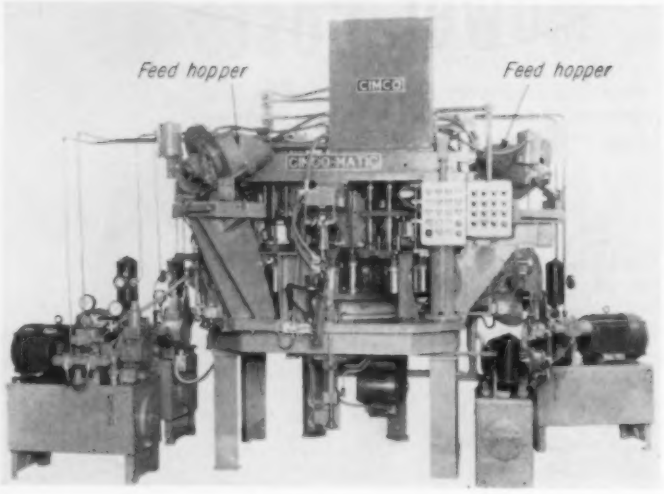
**Zinc and aluminum . . .** diecastings, 19 in all, are used in the Clemson 2-in., self-propelled mower. They include the frame and many parts in the mowing mechanism and engine. As with the Motomower, finishing costs are low because only machining required is broaching, drilling of tapping holes.

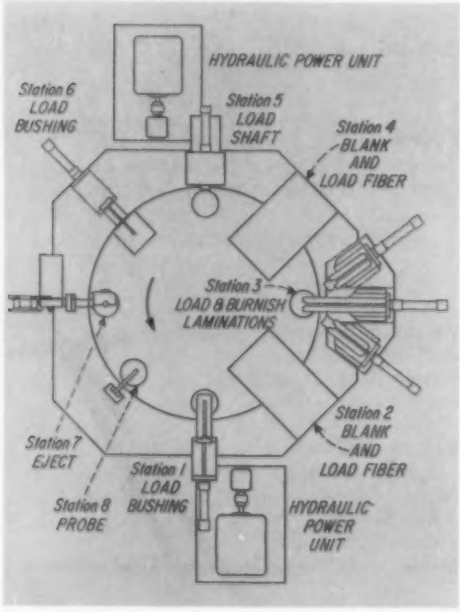


# Armatures — Automatic Assembly

**This machine puts together shaft, bushings, insulators and laminations —totalling 900 armatures per hr for automobile heater motors. An attendant merely services the feeding stations.**

Called the 4CA-54, the machine was made by the Cimco Engineering Co., Ann Arbor, Mich. Adjustments enable it to produce armatures with a range of lamination stack heights and shaft lengths. Minor changes are needed to handle different shaft diameters.

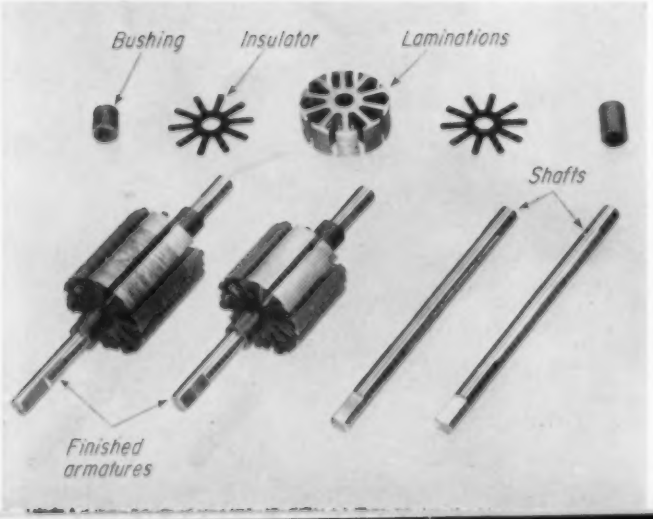




HYDRAULIC POWER UNIT
Station 6 LOAD BUSHING
Station 5 LOAD SHAFT
Station 4 BLANK AND LOAD FIBER
Station 3 LOAD & BURNISH LAMINATIONS
Station 2 BLANK AND LOAD FIBER
Station 7 EJECT
Station 1 LOAD BUSHING
Station 8 PROBE
HYDRAULIC POWER UNIT

## Eight assembly stations . . .

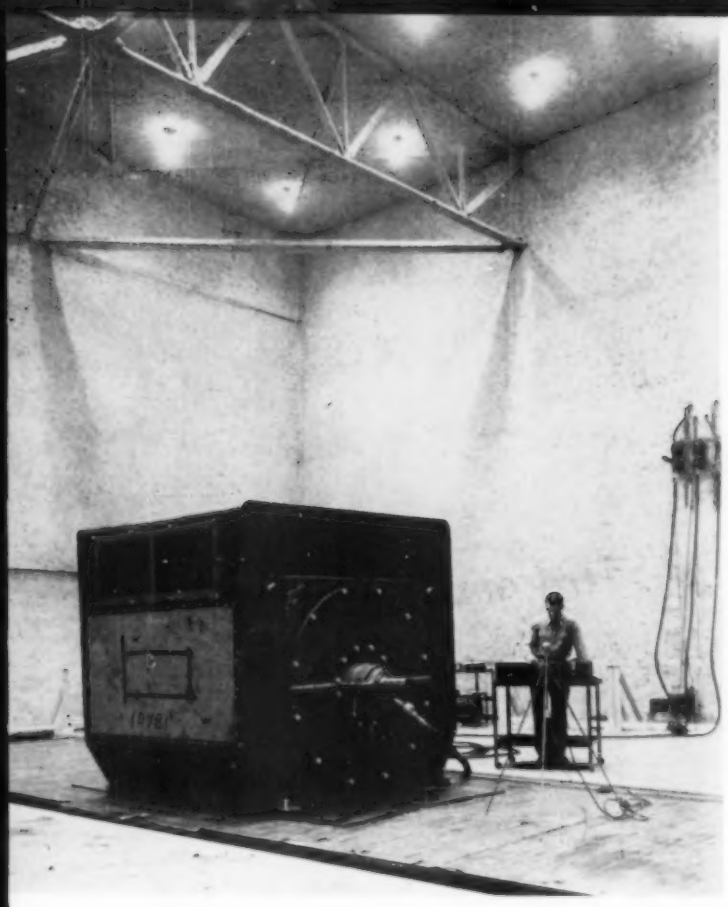
are positioned around a 48-in.-dia dial plate mounted on the 36-in.-dia index table. They cycle in the following sequence:

A bushing is loaded into the fixture on the dial plate at station 1. At station 2, a fiber end-lamination is cut by a 3-stage progressive die and loaded onto the assembly fixture over the bushing. Metal laminations are loaded onto the fixture by 3 shuttles at station 3 and the lamination slots are burnished as they slide on the fixture. Stack height is measured to control the number of laminations loaded onto the fixture. Station 4 cuts and loads a second insulation lamination. At station 5, the stacked parts are compressed by a hydraulic ram while the shaft is forced through them. A second bushing is placed on the shaft at station 6. The armature is pushed out of the fixture at station 7 by a second hydraulic ram. Station 8 probes the fixture for clearance before it starts the next assembly cycle.




## Shaft bushings . . .

are fed into the machine from two hoppers, and shafts from a magazine feeding device. Insulating laminations are die-cut and assembled in the machine. The metal laminations are stamped elsewhere in the plant and conveyed to the magazines. Detectors on these magazines stop the machine if supply gets too low. Another detector, at station 3, stops the machine if assembled stack height is out of tolerance.



**Setting up a large motor . . .**
for noise-testing in the anechoic chamber. The inside wall was formed by spraying an inch-thick coat of asbestos over expanded steel lath.

# A LOW-COST SOUND LAB

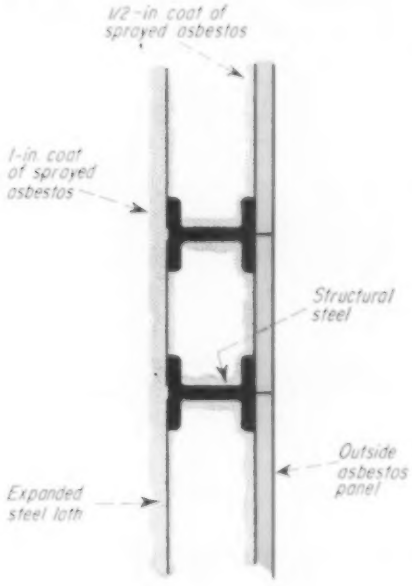
## proves that silence doesn't *have* to be golden

Anechoic chambers—silent labs for noise-testing—don't have to be expensive. For very low-decibel work, of course, the quieter the better; but extra silence costs money. High-level sound testing (80 decibels and above) can be done with relatively little expense.

For example, take the sound lab that Pennsylvania's Elliott Co. built to test its motors and generators. This could almost be called an asbestos lab; it's just an asbestos-covered steel frame. The standard for motor-noise testing is a 50-ft hemisphere of quiet, so Elliott built a box 50 by 52 by 30 ft., with a structural steel framework, and covered the outside with 4-by-10-ft asbestos panels. The panels are actually sandwiches—asphalt-impregnated wood fibers between two slices of asbestos-cement.

Next, builders sprayed the steel frame and inside face of the panels with ½ in. of asbestos, attached expanded steel lath screening and formed an inside wall by spraying it with a 1-in.-thick coat of asbestos. This allowed several inches of air space between walls. The builders kept their spray-guns going until they covered everything inside the building—even girders and doors—with asbestos.

To form the acoustic hemisphere, microphones are placed at 25-ft radii from the rail car which forms the central test platform. The asbestos-damped room does a good job of killing echoes and resonance, especially the 60- and 120-cycle sound that's characteristic of electric motors.

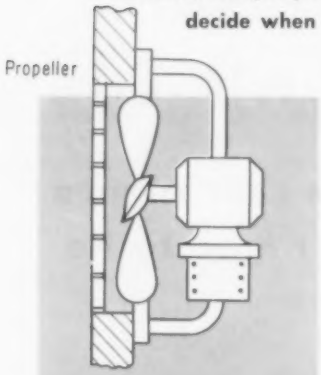



**Outside wall . . .**
of the anechoic chamber wall is Insulpanel, inside wall is Limpet sprayed asbestos, both made by Keasbey & Mattison Co.

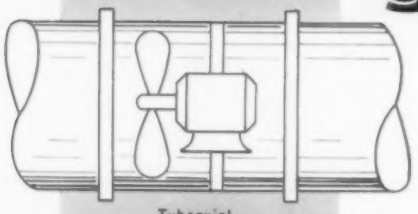
A STAFF REPORT

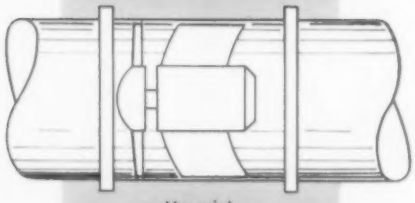
**There are several types, and choosing the right fan is often more than a matter of type. Here are charts, tables, sample problem—and three fan laws that help decide when a smaller unit could do the same job.**

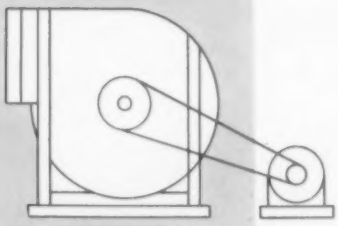
| Type of Fan |
|---|
| **Propeller** |
| **standard** |
| **heavy duty** |
| **Tube axial** |
| **Vane axial** |
| **Centrifugal** |
| **Simple radial blade** |
| **Radial blade** |
| **Forward curve** |
| **—heavy duty** |
| **Backward curve** |
| **—heavy duty** |
| **Airfoil** |
| **—heavy duty** |




# guide to . . . FAN


Tubeaxial


Vaneaxial


Centrifugal

Two main considerations when selecting a fan are type and size. Determining size is simply a matter of using the correct formulas and performance charts. But selecting the correct type depends more on sound judgment than on formulas because there is usually more than one type suitable for a particular application.

The selection table given above will help toward a

### FAN LAWS

What happens when either fan size or operating speed is changed? The answer is found in three laws:

Capacity varies as: $(\text{size}_2/\text{size}_1)^3 \times (\text{speed}_2/\text{speed}_1)$

Static pressure varies as: $(\text{size}_2/\text{size}_1)^2 \times (\text{speed}_2/\text{speed}_1)^2$

Power varies as: $(\text{size}_2/\text{size}_1)^5 \times (\text{speed}_2/\text{speed}_1)^3$

These fan laws, confirmed by test, can be used within these limitations:

They will not hold true for extreme variations in size or speed.

They apply only to geometrically similar fans.

They will not work if blade width or blade angle is varied while diameter is held constant.

If any equipment is added or subtracted, the pressure required for a given flow will change, and fan must be rerated.

## TABLE I—THE ABC OF FAN SELECTION

| Max Static Pressure, in. | Efficiency | Fan Cost | Operating Range | Hp at Constant Speed | Typical Applications |
|---|---|---|---|---|---|
| 0<br>1 | low | low | narrow | Rises sharply at reduced capacities | The best for free-delivery; wall-mounted. For supply or exhaust |
| 2 | medium | medium | medium | " | General ventilating. Moves fair vol. of air at low pressures |
| 3 | medium high | medium high | medium | " | Industrial ventilating. More efficient, more costly, than tube axial. Usually has air-guide blades ahead of vanes |
| 15 | low | low | broad | Rises sharply at increased capacities | Fumes and other industrial exhaust; conveying |
| 70 | medium to high | medium to high | narrow | " | Process gas; air at very high pressures |
| 6<br>15 | medium | medium | narrow | " | Air conditioning, general ventilating. Max efficiency at about max pressure |
| 6<br>15 | medium to high | medium to high | broad | Self-limiting | More efficient at max hp than forward curve. Same applications |
| 6<br>15 | high | high | medium | " | Where efficiency is important. Same applications as forward curve |

# SELECTION

sound choice. It covers the four main fan types: propeller, tube axial, vane axial, and centrifugal. In centrifugal the choice in blades is: radial, forward curve, backward curve or air foil. Selection is also made sometimes on the basis of static pressure requirements. However, manufacturers usually identify a fan with a particular duty, for example: general ventilating, heavy-duty ventilating, industrial exhaust, pressure blower, and mechanical draft.

**General ventilating fans** in duct systems may be tube axial, vane axial, or centrifugal type. Propeller types are used for wall mounting and to blow into or out of a space in roof ventilators. Axial fans are often best choice where duct configurations make straight-through flow desirable. The centrifugal type may have either backward or forward-curved blades, or airfoil blades. All will give excellent service when worked within rating range, and the air is clean.

**Heavy-duty ventilating fans** are centrifugal types designed for higher speeds and pressures. These fans may have backward or forward-curved, or radial blades.

**Industrial exhausters** are usually simple radial-blade centrifugals. The heavier designs will withstand the effects of dirty gas and even "tramp" material passing through the fan. When built along simple lines, even extreme wear can be repaired easily in the field. Under severe conditions, all or part of the fan is considered expendable; so simplicity and low cost are desirable.

**Pressure blowers or process-gas fans** are radial-blade fans suitable for the high speeds required; for example, they have special provisions to prevent leakage.

**Mechanical-draft fans** are subclassified according to specific duty. Both forced and induced-draft types are built along lines of the heavy-duty ventilators to achieve high efficiencies. Bearings are mounted independently of fan housings. Inlet boxes and anti-wear provisions are often incorporated in induced-draft type. When high temperatures, high speeds, or extremely erosive conditions are expected—as in recirculating gas or primary air, or for sintering duty—radial blades or, at least, modified radials are used; wear resistance can be improved by increasing thickness of blades and housings at important points with strips of metal. Corrosion-resistant material can be specified on any type.

### FAN NOISE

Frequency of the noise generated depends mostly on number of blades in the impeller. The number of guide vanes, if any, has some effect too. It is not necessarily true that the higher-speed fans are the noisiest. It is the *most efficient* fan that is usually the quietest. This is why efficiency ratings in the selection table can serve as indicators of relative noisiness. For example, a well-designed vane axial fan should be quieter than a well-designed centrifugal. Because noise levels, as determined by code test, do not necessarily indicate the



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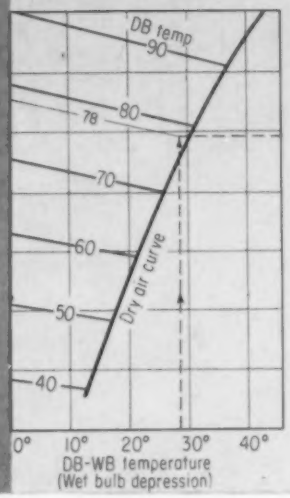
**TABLE II—TYPICAL MULTI-RATING TABLE**
**(for Buffalo centrifugal fan, size 1200)**

| Capacity, cfm | Outlet Velocity, rpm | 1″ $p_s$ | | 1¼″ $p_s$ | | 1½″ $p_s$ | | 1¾″ $p_s$ | |
|---|---|---|---|---|---|---|---|---|---|
| | | rpm | hp | rpm | hp | rpm | hp | rpm | hp |
| 28,980 | 1400 | 322 | 6.29 | 342 | 7.51 | 359 | 8.76 | 378 | 9.98 |
| 31,050 | 1500 | 334 | 6.98 | 353 | 8.25 | 370 | 9.58 | 389 | 10.9 |
| 33,120 | 1600 | 347 | 7.72 | 364 | 9.08 | 382 | 10.5 | 398 | 11.9 |
| 35,190 | 1700 | 359 | 8.55 | 377 | 9.98 | 393 | 11.4 | 409 | 12.9 |
| 37,260 | 1800 | 372 | 9.47 | 390 | 10.9 | 405 | 12.4 | 420 | 14.0 |
| 39,330 | 1900 | 384 | 10.5 | 402 | 12.0 | 418 | 13.5 | 432 | 15.1 |

**TABLE III**




amount of disturbance experienced by the ear, manufacturers have refrained from publishing noise data.

## WHAT SIZE FAN?

Before selecting fan size, flow requirements and fan static pressure must be known. From these, the operating speed and horsepower requirement can be found in charts and tables. However, in any specific system, several fans can do the job. A smaller size can still produce sufficient flow if operated at a higher speed—and therefore at higher horsepower. This reduces efficiency but will also reduce initial cost. Thus, fan-size selection becomes a matter of shopping among specifications.

**Static pressure** $p_s$ can be calculated by computing losses in the various system components and the change in pressure level from entrance to exit of the system. In equation form, the fan static pressure is the difference between total pressure $p_t$ and velocity pressure $p_v$.

$$p_s = p_t - p_v$$

**Velocity pressure** is also equal to outlet velocity at end of the system. This simplifies measurements.

**Total pressure** is equal to sum of the losses in the various system components.

Losses for commercial items such as filters, coils and other devices can be determined directly from manufacturers' data. Losses from standard items such as entrance conditions, ducts, elbows, and changes in section can be determined from charts and tables in reference works such as the American Society of Heating and Air Conditioning Engineers guide. Friction and shock losses are always total pressure losses.

## CHANGES IN STATIC PRESSURE

The difference between system exit pressure $p_{s2}$ and entrance pressure $p_{s1}$ should be included in calculations when (1) some device specifically maintains a pressure at either location, (2) there is an appreciable difference in elevation between the two points, and fluid in the system differs appreciably in density from the surrounding atmosphere. In the first case, the difference can be determined directly, and in the second:

$$p_{s2} - p_{s1} = (0.1925)\ (\text{diff. in elev.})\ (\text{diff. in densities})$$

In either case, where the difference is positive the fan must provide more energy than in a simple system; and where negative, fan requirements are reduced. For example, a negative difference occurs when computing the theoretical draft (neglecting friction) available from a chimney when the flowing gas is lighter than atmospheric air.

Equation for static pressure now becomes

$$p_s = p_t + (p_{s2} - p_{s1})$$

If the fan is upstream of the exit (blowing or boosting), the above equation becomes

$$p_s = p_t + (p_{s2} - p_{s1}) - p_v$$

Many designers ignore the $p_v$ term regardless of fan location. This decision is usually rationalized as providing a factor of safety. However, accuracy is improved by assuming a value for $p_v$ and checking it after initial calculations.

## MULTI-RATING TABLES

Fan performance data are usually available from manufacturers in the form of multi-rating tables.

Table II is an example. Each table gives data on one particular type and size of fan, and contains capacity and static-pressure values with corresponding speeds and horsepowers. The data is based on a standard air density of 0.075 lb/ft³ at 70-F dry air and 29.92 barometric pressure. For other ambient conditions use the density chart, Table III, to find the equivalent static pressure. Interpolation between values can be made on a straight-line basis.

**For example:**

Required: Fan to deliver 35,000 cfm (cu-ft/min) against 1.5 in static pressure. Air enters fan at 78° DB (dry bulb), 49.5° WB (wet bulb) and 28.6 in. Hg (mercury). Select the fan size and find the horsepower required to drive it.

From Table III. Subtracting 49.5 from 78, enter chart (bottom left) at 28.5 wet bulb depression.

Proceed vertically to 78° DB.

Proceed horizontally to 28.6 Hg bar.

Read 0.0708 density directly below.

**PSYCHOMETRIC DENSITY CHART**

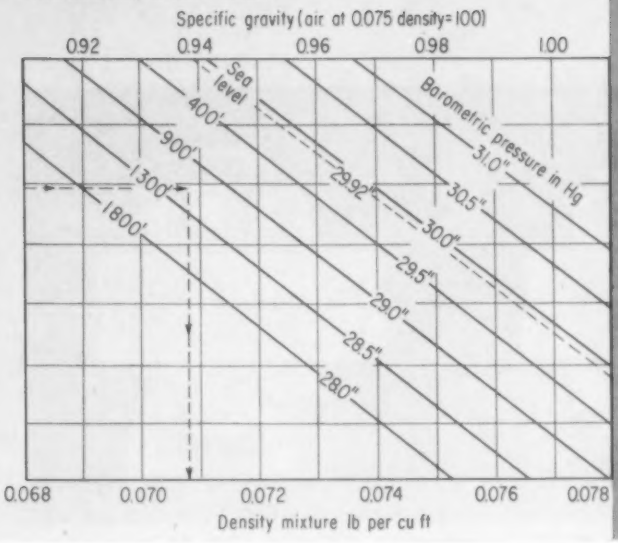
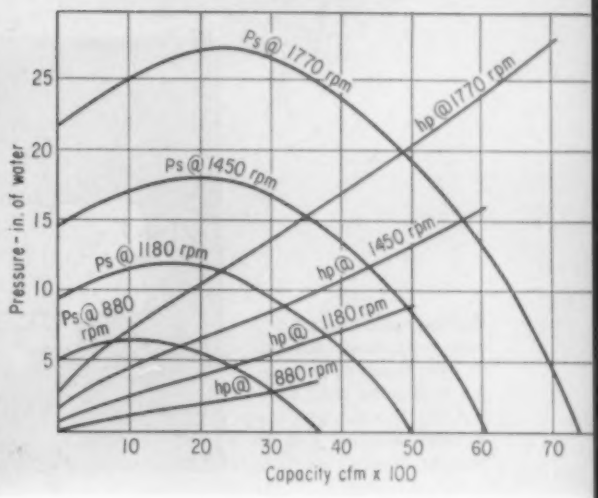



**TABLE IV — CONSTANT-SPEED PERFORMANCE CURVES**
**(for Buffalo centrifugal fan, size 805)**




$$\text{Equivalent } p_s = 1.5 \times \frac{0.075}{0.0708} = 1.59$$

**From Table II**—35,000 cfm falls between 33,120 and 35,190.
1.59 in. $p_s$ falls between 1½ and 1¾
Interpolating: rpm = 398
hp = 11.8 at std. cond.

Converting the hp (because of the difference in densities):

$$\text{hp}' = 11.8 \times \frac{0.0708}{0.075} = 11.2 \text{ hp}$$

Because the multi-rating table is only for one size, several other tables and sizes should be checked in a similar manner to find the most suitable operating speed and power requirement.

## CONSTANT-SPEED CURVES

The operating speeds listed in multi-rating tables may not correspond to a motor speed; such data is more useful for belt-driven fans. For directly coupled fans, constant-speed curves, Table IV, are available; they show several motor speeds for each size fan. For example, the fan in Table IV can deliver 5,000 cfm, standard air density, against 19.4 in. pressure when operated at 1770 rpm, but only 4,400 cfm against 11.8 in. pressure when operated at 1450 rpm.

These tables and curves are for standard fans. By modifying the wheel or adding dampers, the required speed for a given rating can be varied to coincide with a motor speed.

## SELECTING MOTOR SIZE

Motor hp rating should meet or exceed highest requirement of the fan. This should be increased by losses for any V-belts or variable-speed devices between fan and motor.

Temperature also affects hp requirements. When a system for blowing hot gas has to start with the gas cold, hp requirements are more severe:

$$\text{hp (cold)} = \text{hp (hot)} \times \frac{T \text{ (hot)}}{T \text{ (cold)}}$$

where $T$ is absolute temperature (°F + 460).

Horsepower can be conserved by holding down static-pressure and capacity requirements. Frequently the flowing gas or air is heated by some means within the system. Weight of the flow will be constant but cfm will be less on the cold side—so placing the fan on this side will reduce needed power. Required fan pressure, however, will be the same.

## REGULATING VOLUME

These three methods act as controls when the volume of air needs reducing:

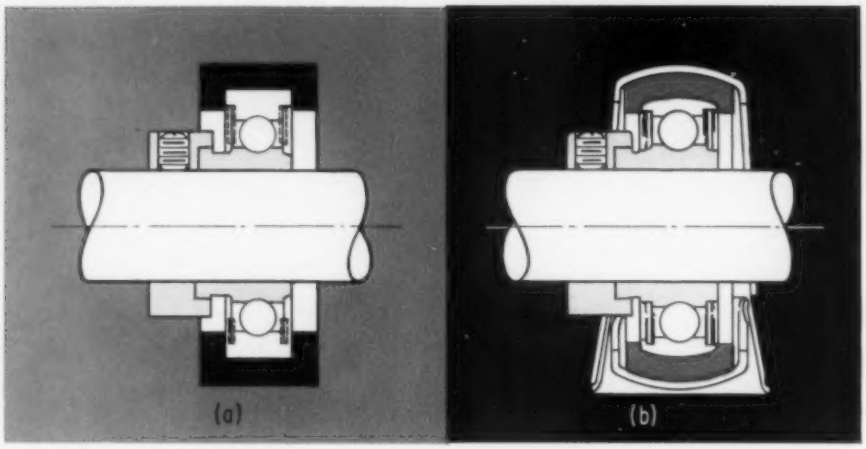
- Dampers in the ducts. When partly closed, a damper causes the fan to operate at a lower point on the constant-speed performance curve. This reduces volume but increases the pressure. Dampers greatly reduce system efficiency and should be avoided with axial fans.
- A variable-inlet vane mounted just before the fan inlet. It spins the incoming air in the same direction the fan is turning. This reduces flow without increasing pressure—a more efficient method than dampers, but also more expensive.
- Controlling the fan with a variable-speed device. If the volume reduction is large, this method requires less power than variable-inlet vanes. For small reductions, fans with a variable-inlet vane save on power.

Because of leakage it is impossible to achieve control over the entire operating range. The leakage past a closed damper or a variable vane will approximate 15%. To minimize leakage, dampers are often used as auxiliaries in conjunction with the other two methods.

REPRINT of this article can be obtained for your reference file by checking No. E21 on one of the Reader Service cards bound in this issue. For other reprints available see "Current Reprints" listing in this issue on page 155.

**EDITOR'S NOTE:** Flow rate and fan static pressure can be also determined by practical test setups described in "How You Can Measure Air Flow," June '57, p 145.

How variations in air density and temperature affect heat transfer in cooling systems is discussed in "Fan Cooling-influence of Altitude," June '56, p 198.




**Rubber sleeves . . .** have been standardized to fit over standard bearings (a), or in pillow block housings (b). The bearings are mounted on shaft and in housing in usual manner.

# RUBBER CUSHIONS . . .

## *when bearings must be Quiet*

**There are many applications where the hum of a mounted bearing can be a severe annoyance. These tests show advantages of enclosing the bearing with a rubber sleeve.**

**RUSSELL E. DOWNES**
*Engineering Manager, The Fafnir Bearing Co.*

Rubber has characteristics making it a killer of noise. This is why it works so well as a sound-reducing sleeve over the outer race of a mounted bearing. Our tests show the cushion will cut the noise power level (energy dissipated in the noise) by over 90% and decibel values by 15%. This is an appreciable amount because decibel readings are logarithmic and because continuous noise, even if only the hum of a bearing, can become severely annoying.

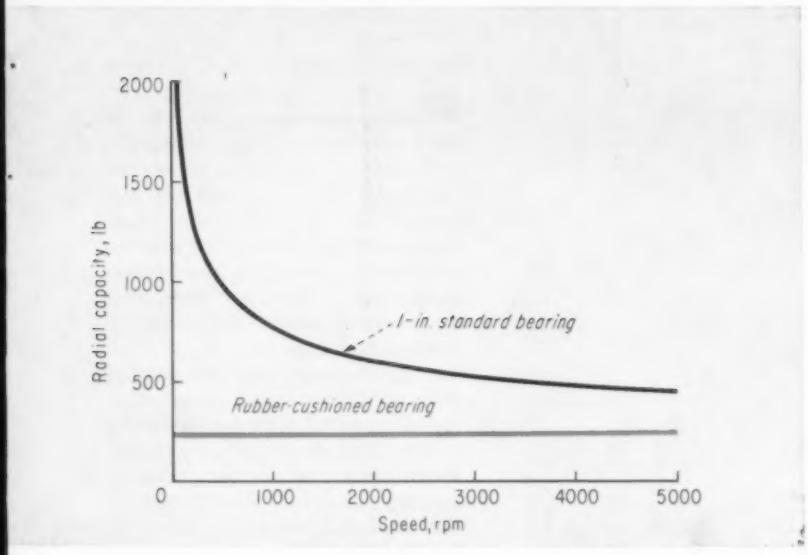
Bearings contribute much sound of this kind to the noise of business machines, air conditioners, dispensing machines, and materials-handling equipment such as conveyors. An average ball bearing mounted in a housing on a base plate has a decibel level in the 70s. This is as bad as traffic noises and any reduction is worthwhile unless, of course, neighboring noises have a much higher sound level.

One approach to noise reduction is with a high-damping material, such as manganese-copper alloy (*PE*—May '56, p. 135). But a rubber sleeve over the outer race is cheaper. The cushioning material also absorbs higher-frequency vibrations and shock loads. Standard bearings now come packaged with such a sleeve—at about 15 cents more per bearing.

Such bearings, however, are only for light-duty applications where radial equipment of the shaft is not a critical requirement. This is because the radial load capacity of the bearing is now limited by the compressive and fatigue strength of the rubber; also the rubber is subject to permanent set after a period of time.

Our tests show that unmounted bearings receive no benefit from cushioning. In a "quiet room" where the background reading was about 25 db, unmounted bearings rotated at 1750 rpm gave the same reading of 53 db whether bare or with a rubber sleeve. But when the bearing was mounted on a base plate, the noise from the bare bearing increased to 73 db, or 100 times the noise power level for the unmounted bearing. Here, the rubber sleeve became important; under the same conditions the noise in mounted bearing increased only to 62 db or less than eight times the noise power level of the unmounted bearing.

Thickness of the rubber sleeves has been found to have little effect on sound-damping qualities. Earlier models had thick rubber housings, requiring springs and clips to ground the static electricity that developed as the isolated shaft rotated in air. These devices were guilty of transmitting much sound. Today's rubber sleeves are made of relatively thin neoprene, which has electrical conductive properties.




**Comparative radial capacity . . .** between standard and rubber-cushioned bearings. Compressive and fatigue strength of rubber sleeve limits capacity of cushioned type.

## Major Causes of Noisy Bearings

**Inherent bearing characteristics**

- Radial clearance too tight or too loose
- Fit between separator and ball too tight or too loose
- Excessive eccentricity
- Excessive face run-out
- Poor race finish

**Lubrication**

- Race damage from lack of lubricant

**Mounting**

- Excessive axial preload
- Shaft fit too tight or too loose
- Housing fit too tight or too loose
- Bent shaft
- Misalignment

**Bearing abuse or negligence**

- Brinelled races and nicked balls
- Dirt, and dirt indentations
- Shield or seal damage, and resultant interference
- Rust

**Poor assembly practice**

- Unbalance or rotating members
- Passage of current through bearing
- Resonance of frames, end bells or fans

## SOUND LEVELS

| decibels | |
|---|---|
| 0 | Threshold of acute hearing |
| 30 | Minimum residential noises |
| 40 | Quiet office; average residence |
| 50 | Typical business office |
| 60 | Automobile |
| 70 | Business machine |
| 80 | Average factory |

EDITOR'S NOTE: For other methods of reducing noise in equipment see:

"Less Noise from Small Engines," Nov 25 '57, p. 95. Describes how gasoline engines can be silenced to acceptable noise levels.

"Noise Control," Nov '56, p. 143. Outlines three major steps of a noise control program and analyzes noise, its sources and control.

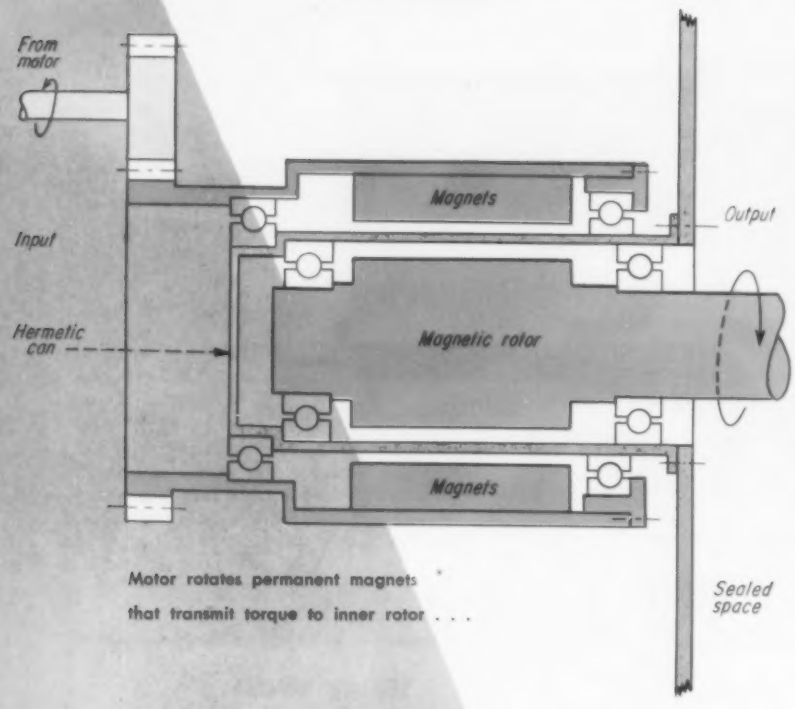
"Keeping Products Quiet," Dec '54, p 150. Specific methods of reducing product noise, with induction motor as an example.

## WHAT HAPPENED at the DESIGN SHOW

PRODUCT ENGINEERING editors attended every technical session, noting the comment of panel members, questions from the floor and discussion.

Every exhibit was visited in a hunt for new design ideas, new materials and components, new production methods and services useful in design and development of products.

Evaluated and written as the Show closed on Thursday of last week, the concise report by our editors is included in this issue starting on page 41.




Motor rotates permanent magnets that transmit torque to inner rotor . . .

. . . FOR SENDING POWER THROUGH A WALL:

# HERMETIC MAGNETIC COUPLINGS

**No more trouble with leaking shaft seals when magnetism turns the rotor. But success depends on the right materials. Article gives results at 50 rpm and predicts design of couplings for 1800 rpm.**

**D. A. GUERDAN**
Bettis Atomic Power Div.
Westinghouse Electric Corp.

Permanent magnets can now be used to transmit torque through a steel wall. A cup-like container does the trick. On the outside of this hermetic can is a rotating force (permanent-magnet assembly revolved by a motor). On the inside is a follower (inner rotor). With no direct connection, shaft seals are eliminated and leakage becomes zero.

A few such couplings, delivering 15 ft-lb at 50 rpm (rated values), have already been built for nuclear power plants. Because of the low speed, eddy-current losses in their hermetic cans are negligible. In this application the sealed environment inside the can contains radioactive water at up to 2000 psi, 200 F. This introduces some complexity. Coupling is run vertically, and output (inner) rotor turns a lead screw to raise and lower a control rod in the reactor pile. Coupling parts, Table 1, are designed to meet these unusual conditions.

A non-nuclear application at 50 rpm is simpler because the extreme pressure and radioactivity are gone. But at higher speeds (up to 1800 rpm) eddy-current losses are greater.

Couplings for 1800 rpm have not yet been built, but Table II predicts data and dimensions based on tested low-speed coupling in Table I. A pressure of 1000 psi inside the hermetic enclosure is assumed. The same design principles and materials are used, but lower pressure allows thinner hermetic-can wall sections. These help reduce the severity of eddy currents.

The idea behind such coupling is simple, but magnetism is involved. This means success depends on choice and use of proper materials. Only certain combinations of magnetic, electrical, mechanical and chemical properties work efficiently. Magnetic and electrical are usually the most critical.

## THE HERMETIC CAN

Material for the can must be permeable to magnetism in the radial direction to give a low effective airgap, but must resist circumferential magnetic flux and circulating electric currents. These would reduce transmitted torque and overheat parts.

Copper (or brass) is unsatisfactory,

particularly at high speeds: its low electrical resistance results in high eddy currents; its low magnetic permeability increases the effective airgap. Ordinary magnetic steel is too permeable, because excessive magnetic flux leaks from one field pole to the next.

A magnetic material giving 40 to 60,000 flux lines/sq in. at 300 amp-turns/in. is desirable. The need is most nearly met by semi-stainless martensitic steels in the 400 series, such as 410 SS, 12.5% chrome. These steels show proper balance of electrical resistance, magnetic permeability, and corrosion resistance. For the can, 410 SS is tempered at 650 F to a hardness of 40 to 45 Rockwell C. This gives an actual tensile strength of 165,000 psi—where design is based on a conservative 35,000 psi. Electrical resistivity is 35 times greater than copper. Replacing the magnetic can with a similar but nonmagnetic one would cut in half the torque values given in Table II, and those in Table I to less than one-third.

Eddy-current losses at 1800 rpm will be very high, even for thin-walled cans of 410 stainless. A theoretical calculation, as yet unchecked by test, is

$$P_L = \frac{K\,R\,L\,N^2\,B_M^2\,D^2}{\rho}$$

where

$P_L$ is loss in kw
$K$ is a constant, $3.5 \times 10^{-10}$
$R$ is can thickness, in.
$L$ is active coupling length, in.
$N$ is speed, rpm
$B_M$ is max flux density, assumed 50,000 lines/sq in.
$D$ is can dia, in.
$\rho$ is resistivity, assumed 66 micro-ohm cm

For example, in the largest coupling (100 ft-lb) the losses are

$$P_L = \frac{(3.5 \times 10^{-10})\,(0.093)\,(13.3)\,(1800)^2\,(50)^2\,(7)^2}{66}$$

$= 18.1$ kw (24.3 hp)

Power output is

$$\frac{T \times \text{rpm}}{5250} = \frac{100 \times 1800}{5250} = 34.3 \text{ hp}$$

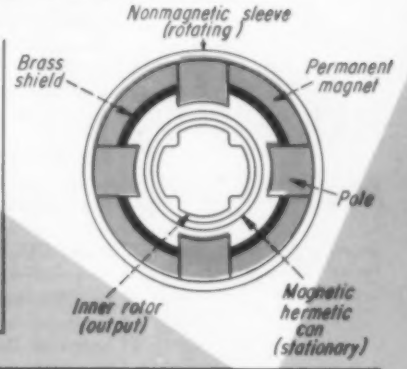
Friction and windage losses might be 5%, therefore coupling efficiency is

$$\frac{34.3}{24.3 + 34.1} - \frac{5}{100} = 53.5\%$$

If such a coupling is built, however, it will require an exceptional amount of cooling. Where this is not practical, then lower speeds must be selected. For example, if speed is lowered 50%, output power also drops 50%, but eddy losses drop 75% . . . a net improvement in coupling efficiency.

**TABLE I—A 50-rpm PERMANENT MAGNET COUPLING**

| Performance (approx.) | |
|---|---|
| Starting torque, ft-lb | 10 |
| Rated torque, ft-lb | 15 |
| Max (pull-out) torque, ft-lb | 20 |
| Transmitted power at rated torque, hp | 0.14 |
| Eddy-current losses, hp | negligible |




| Parts | Materials | Dimensions |
|---|---|---|
| Rotating field assembly: Sleeve | 304 Stainless | OD, 7 in. |
| Magnets | Cast Alnico V | Radial thickness, ⅛ in. Total wgt, 25 lb |
| Poles | Carbon steel | Airgap, 0.015 in. |
| Hermetic can | 410 Stainless, hardened | Wall thickness, 0.125 in. |
| Inner rotor | 410 Stainless, annealed | OD, 4 in. Airgap, 0.019 in. |
| Assembled coupling (less driving motor) | | Active lgth., 8 in. Wgt, 100 lb |

## THE INNER ROTOR

This should be as magnetic as possible. Carbon steel would be best except for lack of corrosion resistance. Chrome plating helps some, but is too porous. Gold plating (0.003 to 0.005 in.) is being considered, but cost is high. Annealed 410 stainless (magnetic) is the best compromise; it has a flux density of 108,000 lines/sq in. for 300 amp-turns/in.

Salient (prominent) poles are machined on the rotor to coincide with the salient poles on the outside field assembly. Starting is by induction: the inner-rotor salient poles act like bars in a squirrel-cage rotor, with strong eddy currents producing temporary magnetic poles that try to follow the rotating outer field. Hold-in at synchronous speed is simply the tendency of the rotor to stay in the position giving greatest permeability for the field-pole magnetic lines of force. Therefore, the rotor salient poles stay opposite the field poles and resist getting out of step. If max (pull-out) torque is exceeded, the coupling will jump from pole to pole resulting in zero theoretical net torque. Therefore operation is synchronous or it won't work at all.

Inner-rotor design could have permanent-magnet poles to give even greater torque. However, the demagnetization effect during starting or temporary slipping becomes serious. High-coercive-force ceramic magnets will withstand demagnetization, but are brittle—not good in shock—and might drop chips inside the airgap. Also, any materials selected must be compatible with the sealed environment.

## ROTATING FIELD

This assembly should have as much permanent-magnet material as possible, with the poles arranged for max torque. In general, more poles give higher pull-out torque. This is because torque can be defined not only as force times lever arm, but also as

## HERMETIC MAGNETIC COUPLINGS

**TABLE II—A HYPOTHETICAL 1800-rpm 4-POLE PERMANENT-MAGNET COUPLING**

**Predicted running performance and dimensions for 1000-psi service based on 50-rpm design and using same basic materials.**

| Running torque (max pull-out), ft-lb | 0.5 | 1 | 10 | 20 | 50 | 100 |
|---|---|---|---|---|---|---|
| Max transmitted power, hp | 0.17 | 0.34 | 3.4 | 6.9 | 17.1 | 34.3 |
| Eddy-current losses, hp | 0.02 | 0.06 | 0.6 | 1.8 | 6.5 | 24.3 |
| Outer sleeve OD, in. | 2.5 | 3 | 6 | 7 | 9 | 11 |
| Hermetic-can wall thickness, in. | 0.045 | 0.045 | 0.045 | 0.062 | 0.062 | 0.093 |
| Inner and outer airgap, in. | 0.005 | 0.005 | 0.010 | 0.012 | 0.018 | 0.025 |
| Inner rotor OD, in. | 1.5 | 2 | 3.5 | 4 | 5.5 | 7 |
| Coupling active lgth., in. | 2 | 2.8 | 5.5 | 8 | 11 | 13.3 |
| Wgt. of permanent-magnet material, lb | 0.8 | 1.6 | 12.6 | 25 | 57 | 103 |

energy change divided by angular change. Four poles, for example, are 90° apart, therefore 45° shaft displacement varies field from max to min. If eight poles are used, then only 22½° angular displacement gives max flux change. Assuming that no flux "smearing" occurs (when poles are close together) and pole shapes are right, end result is higher torque. This is true even if total weight of magnetic material is same. More than eight poles is not advisable.

The permanent-magnet segments should have high magnetic energy, withstand severe demagnetizing influences, and require no keepers during periods of inactivity. No commercial magnets meet all requirements perfectly. Cast Alnico V magnets have high energy per unit volume, but poor demagnetization strength; Alnico VI magnets have less energy but can withstand more demagnetization; and ceramic (such as barium ferrite) have considerably less energy but excellent resistance to demagnetization. Alnico V is selected for best all-around properties.

Placement of the magnets is also important. Maximum energy results from a solid casting of permanent magnet material (such as Alnico V) but premagnetization of the poles (1300 F required) becomes complicated. It is easier (and more damage-proof) to use carbon-steel pole pieces with simple-shape magnet segments recessed between. Nonmagnetic barriers between magnet segments and inner container keep magnet chips from jamming the airgap. The supporting sleeve must be made from nonmagnetic material such as brass or stainless.

The field poles operate essentially as holding magnets (*PE—Sept. 30, '57: Editor's Note on p. 94*). Therefore holding force on steel rotor will be proportional to pole-face area (assuming that complete geometric similarity between couplings is maintained). Torque, a function of holding-force times rotor-dia, then varies as dia times pole-face area which is essentially $dia^3$. This indicates the relative volume of coupling or magnetic material. Deviations will occur because all dimensions (including airgap) are not likely to stay in exact geometric proportion through all coupling sizes. Airgap should be as small as mechanically feasible, which is 0.005 in. minimum.

Electromagnets can replace the permanent magnets, but the required brushes and sliprings take up space and net result is less output for same size. It is also possible to substitute an induction-motor-type stator field for the magnets, but then it is a reluctance motor and not a coupling.

### WILL TAKE ABUSE

The 50-rpm coupling was tested by locking the inner rotor and driving the outer at speeds varying from 5 to 600 rpm for durations of 15 minutes to 1 hr. No loss of torque was observed. Heating in an oven to 480 F for 8 hr temporarily lowered torque 20% but recooling restored full capability. Shocks up to 100 G had no effect except to chip the permanent magnet material, but the chips were safely contained. Vibration to 30 cps at $\frac{1}{32}$ in. amplitude for several hours had no effect on torque.

### LIMITATIONS

Below 1000 rpm, the coupling efficiency is fairly good. Above this speed, eddy losses are too high for efficient operation, and other reasons (such as need for hermetic sealing) must be the justification. Costs can be reasonable, because no critical materials are needed: 50-rpm, 15-ft-lb couplings (less external driving motor) can be built for $500 to $1000 each, depending on quantity.

**EDITOR'S NOTE:** For helpful data on permanent magnets, see "What You Should Know About New Magnets," Dec 2 '57, p 34; "Ceramic Magnets, Dec 8 '56, p 143; "Holding-magnet Design," Sept 30 '57, p 94; "Cunife Magnets," Dec 2 '57, p 8; "Plastic-bound Magnets," Apr 56, p 182.

Eddy-current and magnetic-particle clutches, and hydraulic couplings, are compared in "Controlled Acceleration Devices," Mar 3 '58, p 75. For other coupling and clutching devices: "High speed Electrostatic Clutch," Feb '57, p 189; "Control-rod Drives of at Least Five Types," Dec 30 '57, p 5; and "Fast-acting Magnetic Clutch," Aug '56, p 145.

DOW CORNING CORPORATION

# Silicone News

FOR DESIGN ENGINEERS No. 49

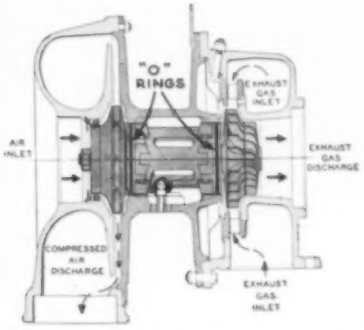
## A DURABLE HOT OIL SEAL

**Immunity to high temperatures or to attack by fuels, oils and solvents makes Silastic*, the Dow Corning silicone rubber, an ideal sealing and gasketing material. How these properties contributed to the reliability and maintenance-free performance of diesel tractors is related by Caterpillar Tractor Co., Peoria, Ill.**

Caterpillar Tractor recently scored an industry "first" by factory-equipping its powerful D-9 heavy diesel crawler with a turbocharger. The application was developed jointly by Caterpillar and AiResearch Industrial Division of the Garrett Corp.

Basically, the turbocharger utilizes the tractor's exhaust gases to force more air into the engine cylinder by means of a turbine driven compressor. The unit increases engine power . . . reduces fuel consumption . . . cuts down smoke and engine roar.

The turbocharger operates at temperatures in excess of 300 F and engine oil pressure is 20 psi. The manufacturer avoided oil seal trouble by specifying Silastic O-rings because they maintain a positive seal and stay resilient despite repeated exposure to oil at elevated temperatures.




Because Silastic stays rubbery from —130 to 500 F and is resistant to weathering, corrosive atmospheres, many fuels, oils and chemicals, it is finding growing use as a sealing material in the aircraft, automotive, appliance, electrical and process industries. * T.M. REG. U.S. PAT. OFF. **No. 496**

## LUBRICATING A SOUND TRACK

**Prolonging the life of recording heads on magnetic tape recorders posed a tricky lubricating problem for EMC Laboratories, St. Paul, Minn. But their ingenious use of Dow Corning 200 Fluid turned the trick and helped them market a new product.**

Dust, grime, grit and friction can quickly wear out the head of a magnetic tape recorder unless it is adequately lubricated. In addition, certain combinations of temperature and humidity will cause the tape to vibrate, in turn distorting the sound or even resulting in an audible squeal.

EMC Laboratories set out to eliminate these problems by developing a suitable lubricant. The company tested a variety of organic oils and greases and found that all of them oxidized and hardened, ruining the responsivity of the equipment.

EMC finally found the desired properties in oxidation-resistant Dow Corning 200 Fluid and developed an excellent lubricant now sold under the trade name "Long Life." The lubricant puts such a thin silicone film on magnetic tape that it's virtually unmeasurable, but very effective and durable. **No. 497**

## No Costly Machining of Parts

**Designers have found a way to increase reliability of electrical components and at the same time cut cost of production. How? Mold parts of Dow Corning silicone molding compound. Case in point: the electric cockpit heater manufactured by Janco Corporation of Burbank, California.** *(Cont. Pg. 2)*

FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE

DOW CORNING CORPORATION

# Silicone News

## NEW LITERATURE AND TECHNICAL DATA ON SILICONES

**1958 Guide to Dow Corning Silicones**—consists of 16 pages filled with data and illustrations suggesting ways in which you can cut costs, simplify designs, improve performance and add new sales appeal to your products with Dow Corning Silicones. Cross indexed for handy reference, this all-new Guide includes properties and uses for the silicone products developed in recent months. *No. 500*

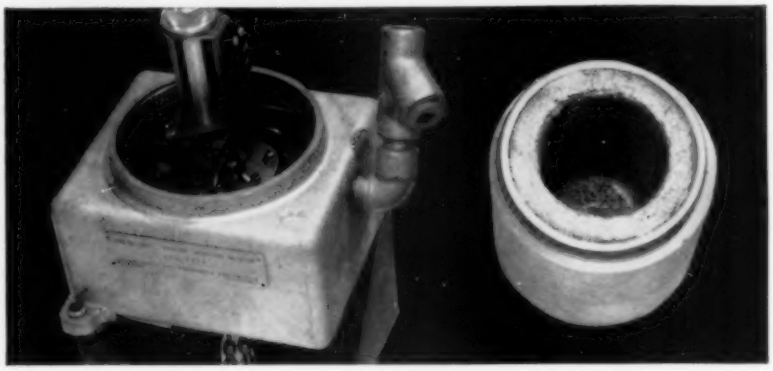
**Silicones as Dielectrics.** Just published. A 12 page, fact-filled must for design engineers. It's a convenient selection guide to the silicone dielectric most adaptable to particular applications that range from electronic components and assemblies to power distribution equipment and motors. *No. 501*

**Silastic RTV** vulcanizes at room temperature. It provides a means of using silicone rubber in those applications where a heat cure is impractical or cannot be tolerated. Available in different consistency grades, Silastic RTV retains good physical and dielectric properties. *No. 502*

**Silicone Coating** for paper and paperboard aids packagers and processors of sticky materials — it keeps gummy and tacky materials from sticking to all types of bags, boxes, innerliners, wrappings and interleaving sheets — it will not migrate nor contaminate goods in contact with it. Send for informative brochure containing sample papers. *No. 503*

**Silicone Bearing Grease,** Dow Corning 44, provides long-time lubrication of ball bearings operating from —40 to 400 F. A brochure includes description of properties and case histories which show that 44 Grease helps cut maintenance costs by lubricating where petroleum greases quickly fail. *No. 504*

**"Rubber From Rock,"** a new color-sound movie, explains how Silastic, the Dow Corning silicone rubber, is manufactured from quartzite. Demonstrates why parts fabricated from Silastic retain rubber-like properties from —130 to over 500 F in a wide variety of military and industrial applications. Also covers uses for Silastic as a dielectric in electronic and electrical equipment. To arrange for a showing of "Rubber From Rock" in your plant, circle *No. 505*



## NEW FOAM-IN-PLACE INSULATION

**A new silicone resinous foam takes most of the work out of installing thermal insulation. To get an effective barrier against heat and cold, simply pour the ready-to-use silicone resin powder in place, apply heat and it foams, filling the available space. No cutting — no fitting — no trimming!**

Here, for example, is the way Consolidated Electrodynamics Corporation, Pasadena, California, utilizes this new silicone resin to simplify production and increase the efficiency of a Process Moisture Monitor. An ultra-sensitive unit designed to detect the presence of water or water vapor in any chemical process steam, the Monitor measures and reports the presence of less than one part water per million.

Accuracy like this depends on the Monitor's internal sampling system being kept at a constant temperature regardless of conditions around the unit or sudden temperature changes in the stream itself. After comparing various thermal insulators, Consolidated found the new silicone foam to be by far the easiest-to-use and the most effective insulation.

To insulate the housing cover, the inside is partially plugged with a solid mandrel and one-third of the remaining void is filled with Dow Corning R-7001. Heating turns the powder into a liquid and makes it foam to fill the void.

MORE FACTS: Foamed structures made from Dow Corning silicone resin have good physical and dielectric properties at temperatures far beyond the range of organic materials. Nonflammable, they have low thermal conductivity and low water absorption. *No. 498*

### NO COSTLY MACHINING *(Cont.)*

A self-contained floor heater, this unit provides auxiliary heat for the crews on Convair's 340 and 440 commercial airliners. Janco recently switched to high temperature Dow Corning silicone molding compound as the material for insulator washers and fuse link blocks in the heaters. Result: greater reliability, reduced maintenance and lower production costs.

Here's why. The silicone parts can be molded into ready-to-use shapes, require no machining. The reject rate has dropped to practically nothing. Performance-wise, the silicone molded parts resist heat much better than the former material and are ten times stronger!

Silicone molding compound has many potential applications on missiles, jet engines and brakes because it's lighter, does not conduct heat like metal and is more corrosion-resistant. *No. 499*

**Dow Corning Corporation, Dept. 864, Midland, Michigan**

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# How does ESNA's complete line turn your special hex nut requirements into standard parts?

TYPES TM and TE
NUT-HEX, LIGHT, THIN
Sizes 3-48 through 1½"-12 • AN364

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NUT-HEX, HEAVY

TYPE TU
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AN365

TYPE Y • DOUBLE HEX
FOR CLOSE CLEARANCES
Sizes 10-32 through ½"-20

ESNA's line of *standard* hex nuts includes so many hundreds of dimensional, material and tensile variations that, in most instances, a *stock* is available to meet your specific needs.

TYPE 1610
NUT-HEX, LIGHT, HIGH TENSILE
Sizes 10-32 through ⅜"-18

For example, all the nuts shown here are standard parts. Yet they range in size from a sub-miniature 0-80 thread that is only .107" across the flats to a 4"-4 thread 6-1/8" across. Thread series include SAE, USS and British BSF, BA and Whitworth series. Most are available in carbon steel, stainless, brass and aluminum. They do not gall or seize bolt threads, and they can be re-used many, many times.

Furthermore, the effectiveness of their red locking collars has been proved by more than thirty years of rugged field service—on locomotives, pile drivers, oil drilling machinery, washing machines, trucks and tractors.

TYPE 1660 MINIATURE
Sizes 0-80 through 4/48

These standard ESNA hex nuts are available from stock or are produced under normal lead times. And, of course, hundreds of other "specials" are also available. For details on the Elastic Stop® nuts shown here, write Dept. *N47-12*.

TYPE 1260 • NUT-HEX, U BOLT
Sizes ⅜-24 through 1¼"-12
HIGH TENSILE

**ELASTIC STOP NUT CORPORATION OF AMERICA**

**2330 Vauxhall Road**

**Union, New Jersey**

TYPE NKM-NKE
NYLON CAP-LIGHT-HEX NUT
Sizes 6-32 through ½"-20

# Surveyed: The Four Broad Types of

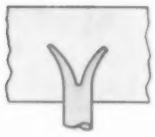
# METAL INSERTS for

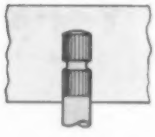
**Plastic moldings sometimes need help from metal inserts to meet design requirements. This survey of the four broad types of inserts can be used two ways: to help in selection, and to spark the answer to a special problem.**

## INSERTS CUT FROM ROUND STOCK

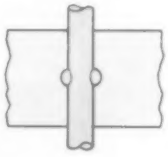
Knurling depth should be about 0.01 in.; annular grooves give increased axial anchorage. Plastic shrinkage alone should not be relied on to provide a firm support for inserts.

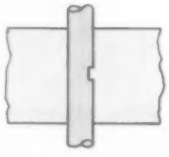
One end buried.

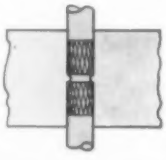




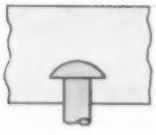
Both ends protruding.

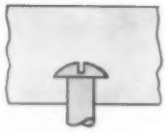


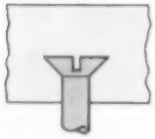


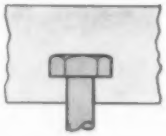


## COLD-HEADED INSERTS



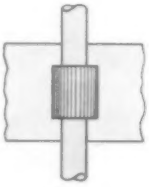


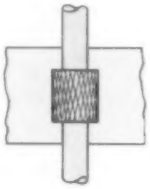


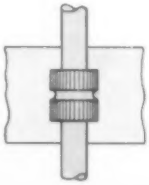


## MACHINED INSERTS

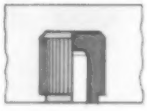
Male

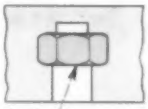






Female



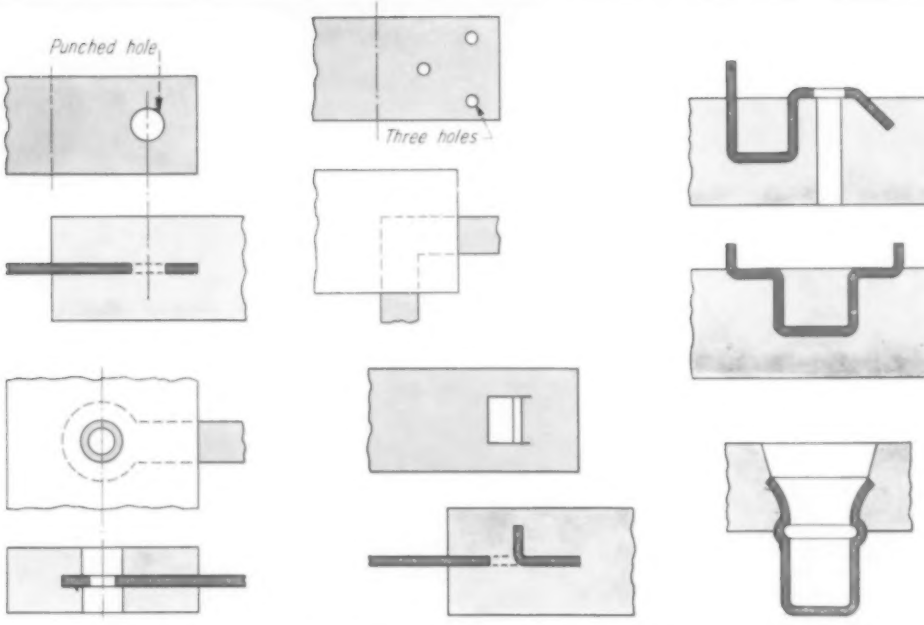


*Standard nut*

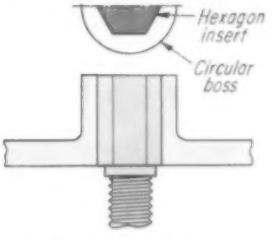
# PLASTIC MOLDING

FEDERICO STRASSER Santiago, Chile

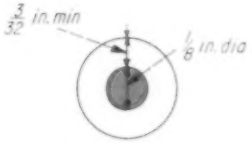
## SHEET METAL–FLAT OR FORMED INSERTS



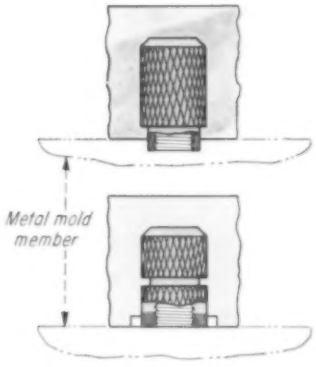

## PRACTICAL HINTS



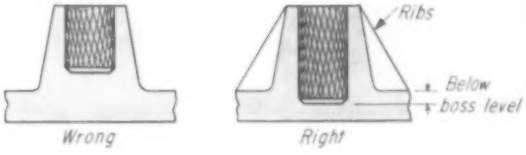

**Provide circular** bosses around noncircular inserts.

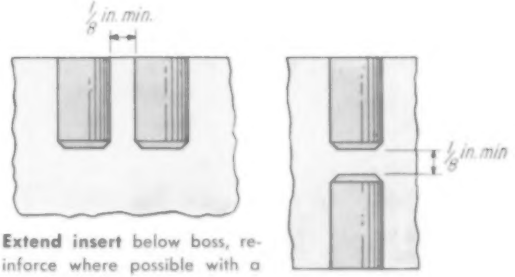



**Minimum recommended** wall thickness in the proportion of 3/32 in. for 1/8-in.-dia inserts.




**Let internally** threaded inserts enter the machine mold to prevent flash getting in thread.



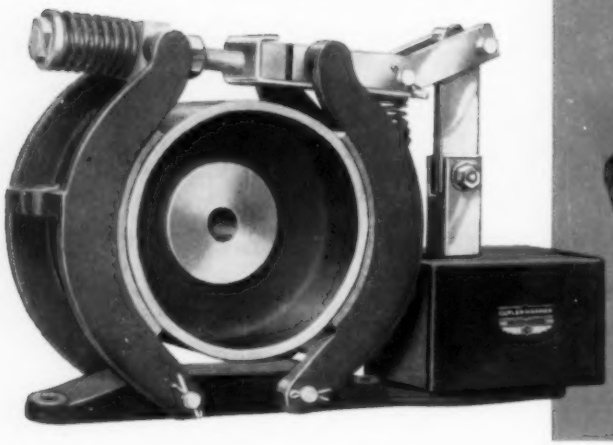

**Extend insert** below boss, reinforce where possible with a couple of ribs.

# THREE good reasons why Cutler-Hammer 511 brakes are preferred throughout industry

**OEM DESIGN ENGINEER—** "We've tested them all and standardized on Cutler-Hammer 511 Brakes. They're easier to install and our customers seem well satisfied too."

**PLANT MANAGER—** "Our conveyor system came equipped with Cutler-Hammer Brakes and they haven't given us a bit of trouble since the system went into operation."

**MECHANICAL MAINTENANCE MAN—** "As part of my job I service the brakes on our cranes and not only are the C-H solenoid brakes easier to adjust, but they hold their adjustment longer than any we ever had."



CUTLER-HAMMER
MOTOR CONTROL
C-H

You, too, will find it pays to specify and install Cutler-Hammer 511 Solenoid Brakes. Available for either A-c or D-c service, Cutler-Hammer 511 Solenoid Brakes are rated from 3 to 125 lbs. ft. torque continuous duty and 3 to 160 lbs. ft. torque intermittent duty. Write today for Bulletin 511 for complete description, ratings, optional features, and dimensions. CUTLER-HAMMER Inc., 1332 St. Paul Avenue, Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer Ltd., Toronto.

REFERENCE BOOK SHEET

**When design calls for an electric motor, will its starting current exceed NEMA limits? What are these limits?**

# how to figure STARTING CURRENT from NEMA code letters

**CHARLES C. LIBBY,** *Manager Electrical Dept. Fairbanks, Morse Co., Fairlawn, N. J.*

Power companies usually limit the max current that may be drawn from their supply lines by a motor. This limitation determines the max horsepower of the most popular motor-starter combination—a squirrel-cage motor and across-the-line starter. If a large-horsepower motor is needed either a reduced-voltage starter or a part-winding-start motor and part-winding starter unit may be required. More expensive slip-ring motor may even become necessary.

Current limitations may be given either as max amperes for a specified voltage, or max percent of full-load current.

To find the amperes or percent starting current of a motor, or to specify the correct motor to meet a power-company limitation, refer to the NEMA code letter (on the nameplate) and corresponding KVA per hp in table at right. Starting current is given by

$$\frac{(\text{KVA per hp})\ (\text{motor hp})}{\text{constant}}$$

The constant (see table below) is a function of KV, thus the answer is in amp.

The ratio

$$\frac{(\text{KVA/hp})\ (\text{efficiency})\ (\text{power factor})}{0.746}$$

yields percent full-load current for any 60-cycle, NEMA type B, C, or D motor. Percent starting current and KVA/hp are not directly related when motors of different sizes or NEMA design are compared: the product of efficiency and power factor varies with motor size and design.

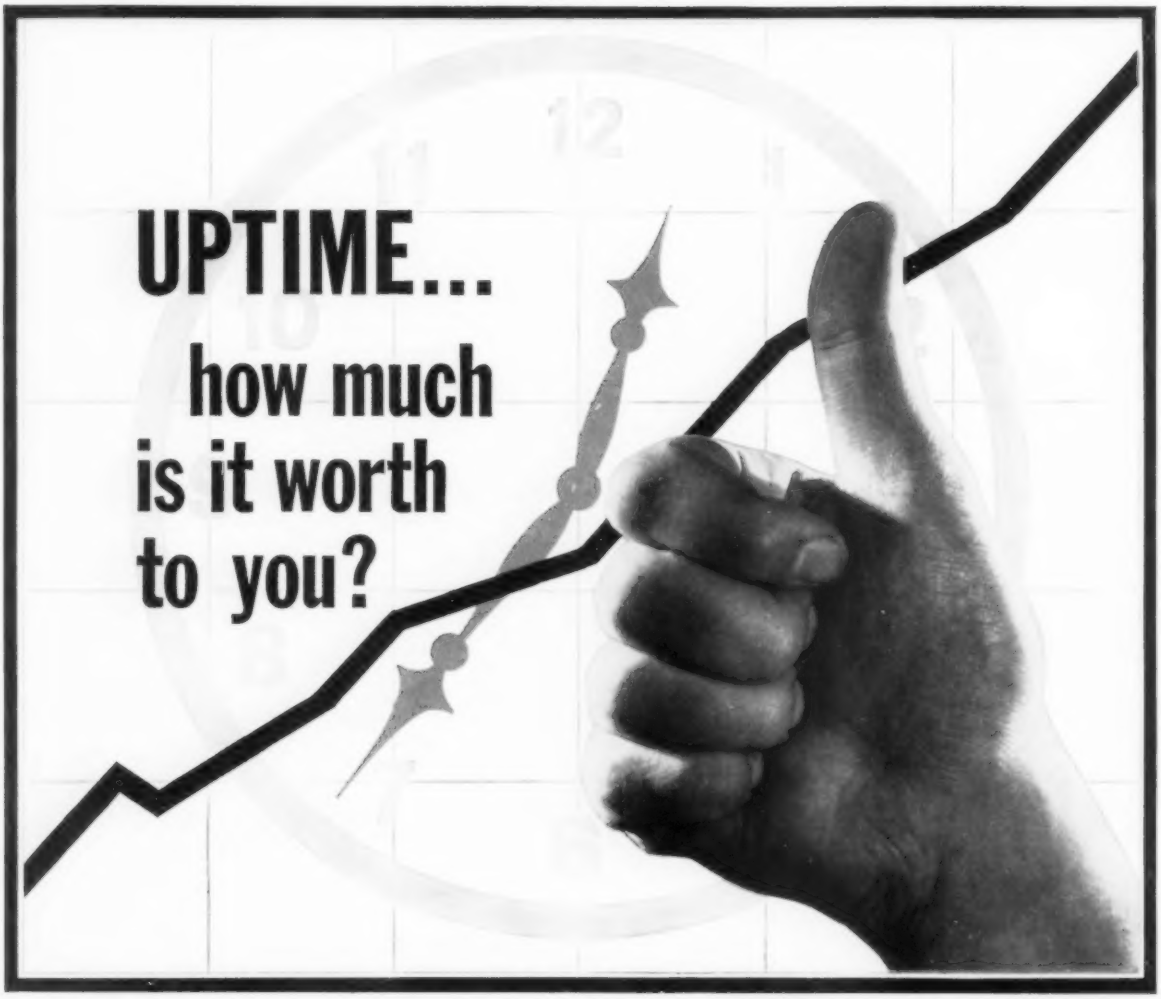
(continued on page 109)

| Power Supply | Constant |
|---|---|
| **3-phase,** | |
| 208v | 0.360 |
| 220v | 0.381 |
| 440v | 0.762 |
| 550v | 0.952 |
| 2300v | 3.99 |
| **2-phase,** | |
| 3 wire, 220v | 0.311 |
| 3 wire, 440v | 0.622 |

| NEMA Code-letter Designation | Locked Rotor KVA Per hp |
|---|---|
| A | 0 to 3.15 |
| B | 3.15 to 3.55 |
| C | 3.55 to 4.0 |
| D | 4.0 to 4.5 |
| E | 4.5 to 5.0 |
| F | 5.0 to 5.6 |
| G | 5.6 to 6.3 |
| H | 6.3 to 7.1 |
| J | 7.1 to 8.0 |
| K | 8.0 to 9.0 |
| L | 9.0 to 10.0 |
| M | 10.0 to 11.2 |
| N | 11.2 to 12.5 |
| P | 12.5 to 14.0 |
| R | 14.0 to 16.0 |
| S | 16.0 to 18.0 |
| T | 18.0 to 20.0 |
| U | 20.0 to 22.4 |
| V | 22.4 and up |

PACKING

# UPTIME... how much is it worth to you?



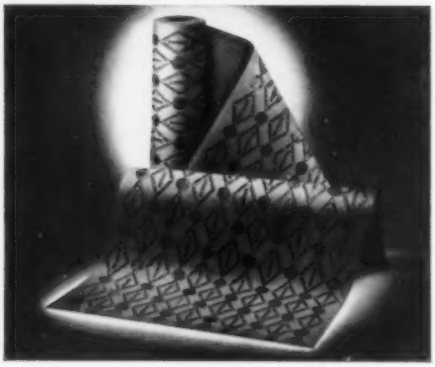
These days, everyone talks about *downtime costs*. Few consider how much *uptime is worth*—the great majority of time when production runs smoothly. How much is uptime worth to *you*, each hour? $100–$200–$300?

And how much are you willing to spend each hour for a packing that will help keep your pumps and flow lines maintenance free? 1¢ – 2¢ – 5¢?

That's the kind of money involved when you use a packing like U. S. Rainbow®—first in red sheet packing. Each extra hour of production uptime means hundreds of dollars in production, yet those same extra hours of packing uptime can be had for just pennies... the difference in cost between a quality packing like U. S. Rainbow and ordinary packings.

Rainbow is designed to pack flanges or other parallel surfaces against hot or cold water, air, saturated steam (up to 150 lbs.) and many other hydraulic conditions—and to pack them for longer hours of *uptime*.

U. S. Rainbow is one of a complete line of quality industrial packings available at your local "U. S." Distributor, or by writing us at Rockefeller Center, N. Y. 20, N. Y. In Canada, Dominion Rubber Co., Ltd.



See the "U. S." exhibit—A.S.T.E. Show
Booth 1233

Mechanical Goods Division

**United States Rubber**

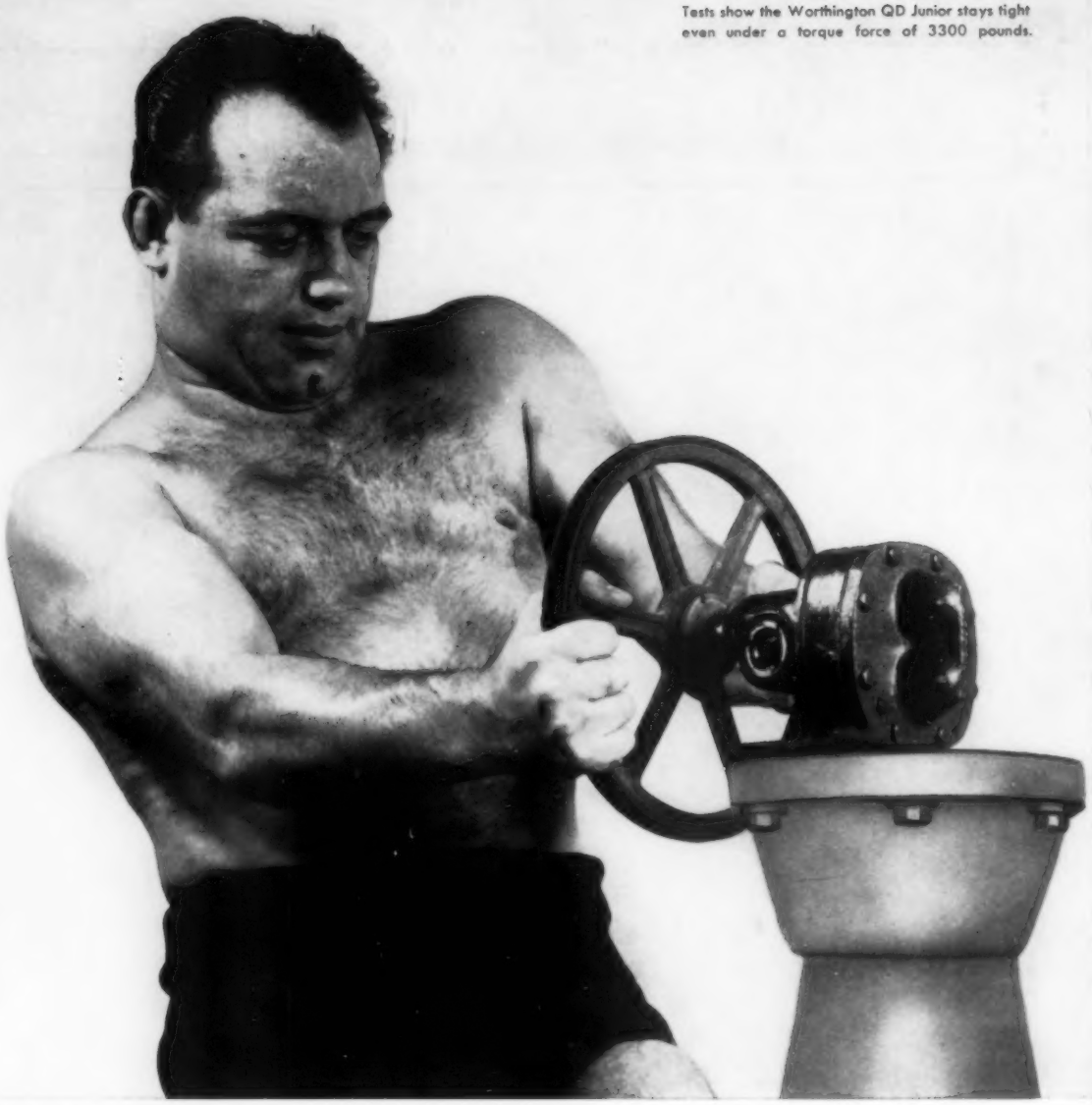
See things you never saw before. Visit U. S. Rubber's New Exhibit Hall, Rockefeller Center, N. Y.

## RELATIONSHIP OF CODE LETTER FOR LOCKED CURRENT AND HORSEPOWER

| CODE LETTER | | | A | B | C | D | E | F | G | H | J | K | L | M | N | P | R | S | T | U | V |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LOCKED KVA PER HP | | | 0 to 3.15 | 3.15 3.55 | 3.55 4.00 | 4.00 4.50 | 4.50 5.00 | 5.00 5.60 | 5.60 6.30 | 6.30 7.10 | 7.10 8.00 | 8.00 9.00 | 9.0 10.0 | 10.0 11.2 | 11.2 12.5 | 12.5 14.0 | 14.0 16.0 | 16.0 18.0 | 18.0 20.0 | 20.0 22.4 | 22.4 UP |
| NEMA LIMITS Current | Code | H.P. | 3-PHASE LOCKED CURRENT AT 220 V (For other voltages multiply current by 220 new voltage) | | | | | | | | | | | | | | | | | | |
| 24 | L | 1 | 8.27 | 9.32 | 10.5 | 11.8 | 13.1 | 14.7 | 16.5 | 18.6 | 21.0 | 23.6 | 26.2 | 29.4 | 32.8 | 36.7 | 42.0 | 47.2 | 52.5 | 58.8 | |
| 35 | K | 1½ | 12.4 | 14.0 | 15.8 | 17.7 | 19.7 | 22.0 | 24.8 | 28.0 | 31.5 | 35.4 | 39.4 | 44.1 | 49.2 | 55.1 | 63.0 | 70.9 | 78.7 | 88.2 | |
| 45 | K | 2 | 16.5 | 18.6 | 21.0 | 23.6 | 26.2 | 29.4 | 33.1 | 37.3 | 42.0 | 47.2 | 52.5 | 58.8 | 65.6 | 73.5 | 84.0 | 94.5 | 105 | 118 | |
| 60 | J | 3 | 24.8 | 27.9 | 31.5 | 35.4 | 39.4 | 44.1 | 49.6 | 55.9 | 63.0 | 70.9 | 78.7 | 88.2 | 98.4 | 110 | 126 | 142 | 158 | 176 | |
| 90 | H | 5 | 41.3 | 46.6 | 52.5 | 59.0 | 65.6 | 73.5 | 82.7 | 93.2 | 105 | 118 | 131 | 147 | 164 | 184 | 210 | 236 | 262 | 294 | |
| 120 | G | 7½ | 62.0 | 69.9 | 78.7 | 88.6 | 98.4 | 110 | 124 | 140 | 158 | 177 | 197 | 220 | 246 | 276 | 315 | 354 | 394 | 441 | |
| 150 | G | 10 | 82.7 | 93.2 | 105 | 118 | 131 | 147 | 165 | 186 | 210 | 236 | 262 | 294 | 328 | 367 | 420 | 472 | 525 | 588 | |
| 220 | F | 15 | 124 | 140 | 158 | 177 | 197 | 220 | 248 | 280 | 315 | 354 | 394 | 441 | 492 | 551 | 630 | 709 | 787 | 832 | |
| 290 | F | 20 | 165 | 186 | 210 | 236 | 262 | 294 | 331 | 373 | 420 | 472 | 525 | 588 | 656 | 735 | 840 | 945 | 1050 | 1176 | |
| 365 | F | 25 | 207 | 233 | 262 | 295 | 328 | 367 | 413 | 466 | 525 | 590 | 655 | 735 | 820 | 919 | 1050 | 1181 | 1312 | 1470 | |
| 435 | F | 30 | 248 | 279 | 315 | 354 | 394 | 441 | 496 | 559 | 630 | 709 | 787 | 882 | 984 | 1102 | 1260 | 1417 | 1575 | 1764 | |
| 580 | F | 40 | 331 | 373 | 420 | 472 | 525 | 588 | 661 | 745 | 840 | 945 | 1050 | 1176 | 1312 | 1470 | 1680 | 1890 | 2100 | 2351 | |
| 725 | F | 50 | 413 | 466 | 525 | 590 | 656 | 735 | 827 | 932 | 1050 | 1181 | 1312 | 1470 | 1640 | 1837 | 2100 | 2362 | 2624 | 2939 | |
| 870 | F | 60 | 496 | 559 | 630 | 709 | 787 | 882 | 992 | 1118 | 1260 | 1417 | 1575 | 1764 | 1968 | 2204 | 2519 | 2834 | 3149 | 3527 | |
| 1085 | F | 75 | 620 | 699 | 787 | 886 | 984 | 1102 | 1240 | 1397 | 1575 | 1771 | 1968 | 2204 | 2460 | 2756 | 3149 | 3543 | 3937 | 4409 | |
| 1450 | F | 100 | 827 | 932 | 1050 | 1181 | 1312 | 1470 | 1653 | 1863 | 2100 | 2362 | 2624 | 2939 | 3280 | 3674 | 4199 | 4724 | 5249 | 5879 | |
| 1815 | F | 125 | 1033 | 1164 | 1312 | 1476 | 1640 | 1837 | 2067 | 2329 | 2624 | 2952 | 3280 | 3674 | 4101 | 4593 | 5249 | 5905 | 6561 | 7348 | |
| 2170 | F | 150 | 1240 | 1397 | 1575 | 1771 | 1968 | 2204 | 2480 | 2795 | 3149 | 3543 | 3937 | 4409 | 4921 | 5511 | 6299 | 7086 | 7873 | 8818 | |
| 2900 | F | 200 | 1653 | 1863 | 2100 | 2362 | 2624 | 2939 | 3307 | 3727 | 4199 | 4724 | 5249 | 5879 | 6561 | 7348 | 8398 | 9448 | 10498 | 11757 | |

**NEMA limits . . .**

for motor designs B, C and D for nameplate codes A to V. Color area shows locked rotor currents which exceed NEMA limits but may be permitted by some power companies. Example. A 7½-hp motor with 118 amp locked-rotor current would be classified Code G, and current falls within NEMA limits.



Tests show the Worthington QD Junior stays tight even under a torque force of 3300 pounds.

## the little

# SHEAVE WITH THE BIG GRIP

The Worthington QD Junior is built for a lifetime of service. Like the famous heavy-duty QD, this two-piece, light-weight sheave has a heavyweight's grip. It's built for staying power—won't loosen or slip under shock or pulsating loads. Yet it's always easy to remove from the shaft.

**1.** *Improved hub design* patterned after our heavy duty QD—tapered, split. A Worthington development to grip the shaft and still provide easy assembly and removal.

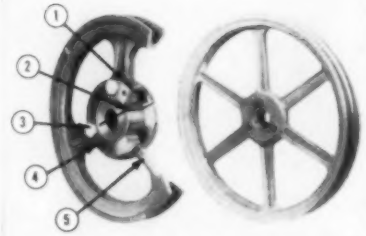
**2.** *One common hub* for complete range of pulleys in "A" and "B" Section, 3.2" PD through 18.4" PD in single and double groove—108 sizes in all.

**3.** *Simple 2-piece assembly* drawn up by three heavy hex head bolts. A standard wrench is all you need to assemble or remove.

**4.** *Tapped holes in sheave* for using pull-up bolts to break cone grip when removing pulley from hub.

**5.** *Distinctive I-beam arm* (in larger sizes) to give more strength with less weight.

Get all the facts. Write for your free copy of descriptive bulletin FHP-100-B1. Worthington Corporation, Section 79-8, Oil City, Pa.




Single Groove • Two Groove

**WORTHINGTON**

# NEW COMPONENTS and MATERIALS

## DETECTS MINUTE CHANGES . . .

in distance between an object and sensing element, without contact with the object being sensed. Electronic control is preset to a desired constant and recognizes change from the constant. Control signals whether change is plus or minus, by actuating a plus or a minus relay. Accuracies of 0.001 in. may be achieved if sensing element is within $\frac{1}{2}$-in. of object. Sensing element has no moving parts and may be located up to 10 ft away from control cabinet. Unit can recognize ferrous or non-ferrous, conductive or non-conductive objects. Operates on 115 v, 60 cps. Control can be used to check size, thickness, coating presence or thickness or deviation between two points. Price is $490, FOB Buffalo, 2-wk delivery. **Security Controls, Inc., 502 Franklin St., Buffalo 2, N. Y.**

Circle 1, inside back cover

## SIX-CHANNEL PROGRAMMER . . .

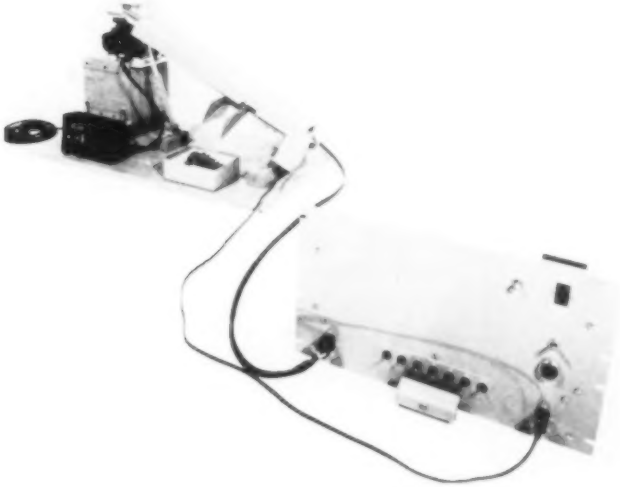
for industrial and laboratory use controls up to 12 timed functions at preset intervals. It functions by providing electrical pulses at pre-determined, controlled intervals through six independent channels. A sensing device reads pulses through holes or slots punched in a continuous loop insulating tape that is drawn past sensing device. Current actuates six 6PDT relays built into unit. A punch locates holes in tape with 0.001 sec accuracy. Delivery, 30 days after receipt of order. $295.00 each. **Beattie-Coleman, Inc., 1000 N. Olive St., Anaheim, Calif.**

Circle 2, inside back cover

## PRESET BATCH COUNTING . . .

of small parts may be accomplished at a rate of up to 1000 per sec. Unit will count any item passed through a light beam. Predetermined selection of the number of parts to be counted is made possible by plugs marked with the number of items to be tallied. The electronic unit utilizes plug-in circuits that are said to be easily serviced by nontechnical personnel. A photo-transistor and light beam are used at the tallying point. Desired number of inputs is accumulated from the pickup device and 110-v ac signal is provided to control parts-handling equipment. Particularly adaptable to automatic packaging equipment. $750 for basic counter only; 60 to 90 days for delivery. **Electronic Engineering Co. of Calif., 1601 E. Chestnut, Santa Ana, Calif.**

Circle 3, inside back cover

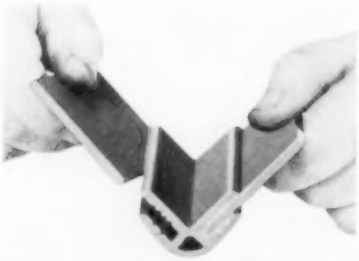


CONTINUED ON PAGE 112

### Hydraulic time delay . . .

uses the compressibility of contained liquid to absorb up to 98% of input energy. Standard model has a time delay of 1 sec, but units may be provided with delays from 1 sec to ½ hr on a ½-in. stroke. Built in sizes up to 44,000 in.-lb. of energy absorption with up to 2-in. stroke. Any mounting arrangement and any input velocity may be built into units. Priced from $69.50 to $124.75 each. Delivery is from 2 to 10 days. **Taylor Devices, Inc., N. Tonawanda, N. Y.**

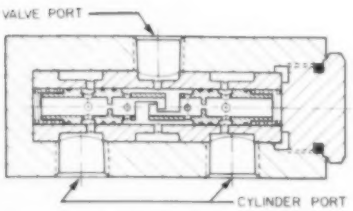
Circle 4, inside back cover



### Slotted strips join PVC sheets . . .

fitting tightly at the outside edge to provide clamping pressure. Solvent welding replaces normal hot air welding of PVC stock. Two shapes, 90° strips for corners and H strips for use in a single plane, are available in normal and high-impact PVC. Can be used with ¼, ⅜ and ½-in. gage sheet. Standard strip is 10 ft long. Extruded structural angles in 10-ft lengths, for flanges and stiffeners of fabricated sections, are offered in 1½ x 1½ x ⅜ in. and 2 x 2 x ¼ in. sizes. **Industrial Div., Colonial Plastics Mfg. Co., 2685 E. 79th St., Cleveland 4.**

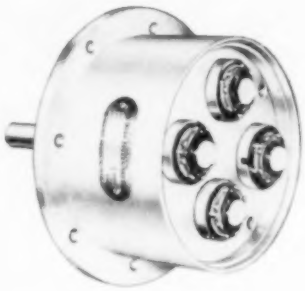
Circle 5, inside back cover




### Flow divider . . .

can be used to divide the flow from a single pump into two equal parts or to combine two flows into one. Said to be accurate within 10% of total flow. Normally used where two hydraulic cylinders are to be moved simultaneously and parallel to one another. Operates as a pair of pressure-compensated flow regulators to keep pressure drop equal across two orifices. In 1-to-4-gpm and 3-to-10-gpm sizes. Equipped for ¾-in. pipe size and designed for service at 2000 psi. **Fluid Controls, Inc., 1284 N. Center St., Mentor, Ohio.**

Circle 6, inside back cover



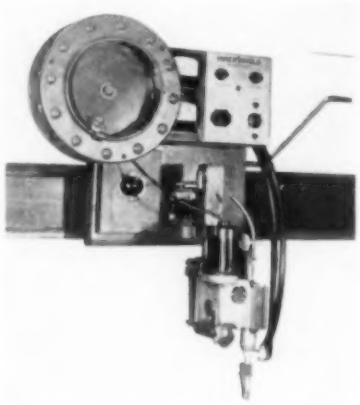
### Speed detector . . .

can control multiple circuits. Up to eight separate speed-sensing switches can be incorporated into an aluminum housing, 5 in. dia x 4 in. deep. Each switch controls one circuit, which can be actuated by a high-speed limit and low-speed limit. Action is determined by speed alone, regardless of load or voltage. Can be supplied in accuracies to ¼ of 1%. Life cycle is from 1.5 to 3 million cycles. Switches require a rapidly decreasing rate of pressure at the critical switching point. Combined with rapidly increasing centrifugal force, this eliminates flutter or chatter. Applicable to diesel-engine control, control of multiple speeds on machine tools, control of interrelated speeds in automated systems, synchronization of separate drives, and for actuating aircraft and missile circuits that can be controlled as a function of speed. **Torq Engineered Products, Inc., 32 W. Monroe St., Bedford, Ohio.**

Circle 7, inside back cover

### High-speed welding process . . .

and equipment arc welds steel at speeds to 300 in. per min. Uses a new flux-containing, coiled-wire electrode that produces a vapor shielding for an open arc. No fluxing or shielding agents are added to arc from external sources—all materials are integrally contained in electrode. Process will make welds ranging from lap welds in 16-gage material to butt welds in ¼-in. plate. Equipment includes a new welding head that controls electrode feed and a motor-generator power source that supplies



400 to 1000-amp welding current. Control circuit for welding head adapts to machines and fixtures for high-volume, production welding. In addition to basic current and voltage controls, head provides inching speed control, a special timer and current controls. Typical jobs are small-dia circular or round-about welds, automotive parts and pressure tanks. Head, controls and power source cost about $2500. **Lincoln Electric Co., Cleveland 17.**

Circle 9, inside back cover

### Self-cleaning soldering flux . . .

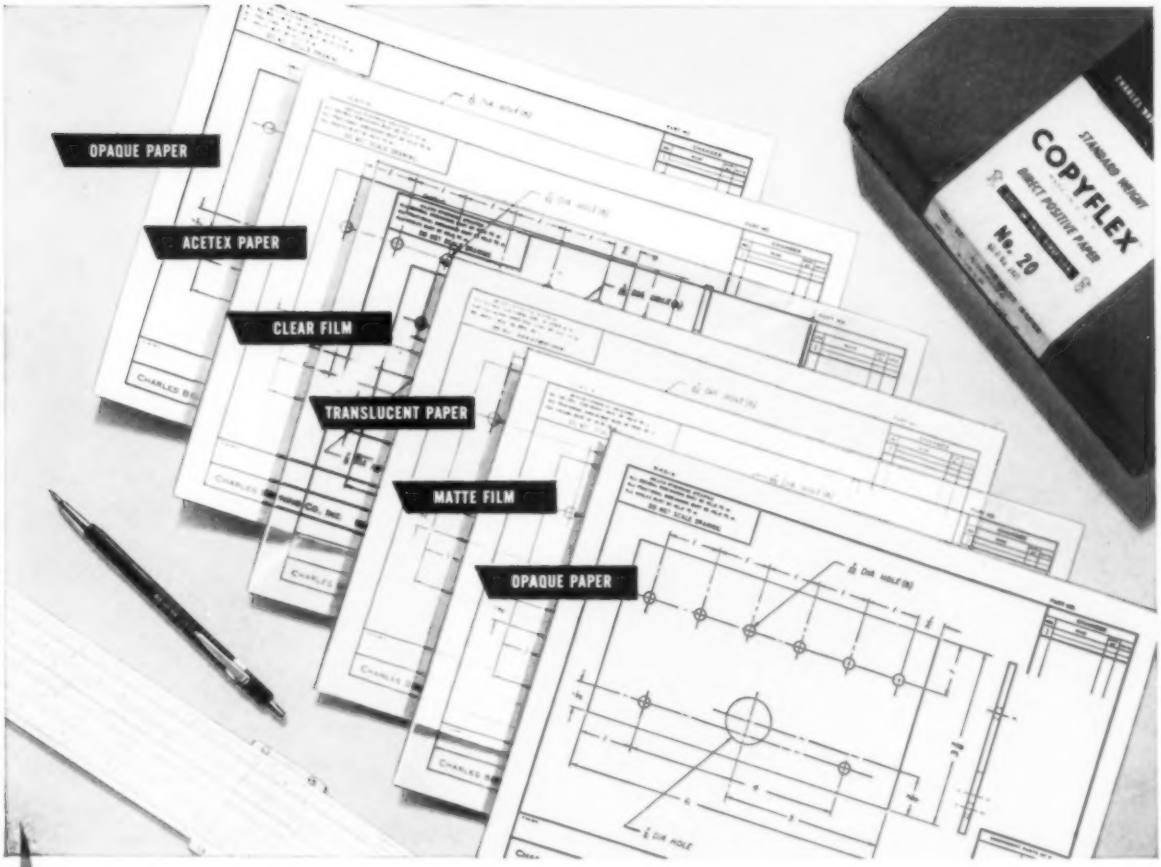
eliminates buildup of gummy residue while dissolving oxide, rust and dirt on the surface and gives clean, nonporous tinning. Accepted spreading drop test on oxidized copper, steel, brass, bronze and terne plate is reported to show up to 200% more coverage than comparative chloride fluxes under like conditions. $4.25 per gal, FOB Philadelphia; 10% discount on 6 gal. **Farrelloy Co., 1241 N. 26th St., Philadelphia 21, Penna.**

Circle 8, inside back cover

### Solid-state resistors . . .

respond to an increase in temperature with an increase in resistance that rises rapidly along a stable, retraceable characteristic curve. Silicon resistors have a 0.7%/°C positive-temperature coefficient of resistance. In two configurations, an axial-lead molded device that is linearly derated at full load from 212 to 302 F and an encased model in a round-welded package that is derated linearly from 257 to 392 F. Both units are immediately available in commercial quantities in standard resistance ratings from 100 to 1000 ohm at 77 F. Resistors are expected to have wide application as a temperature-compensating

CONTINUED ON PAGE 114




# *Here's Colorful Versatility in Reproduction Materials!*

The utility of any reproduction machine depends greatly on the variety and quality of materials available for making prints. Shown above are a few in the complete line of Bruning Copyflex Sensitized Reproduction Materials. Copyflex materials work together with Copyflex reproduction machines to give you faster, better, more versatile reproduction.

## BRUNING SENSITIZED OPAQUE MATERIALS.

*Copyflex Papers* come in three weights of white and a variety of tints. Different Copyflex developing solutions produce different color images, permit many color combinations. You can get papers coated on both sides for two-sided printing.

*Cardstocks* are available in three weights, in white and variety of tints. Tints are useful for indicating design alterations, identifying different filing periods, and color-coding the distribution of prints.

*Acetate Coated (Acetex) Papers* are white or aluminum color. Smooth, glossy, surfaces are eye-appealing, washable and durable. Brilliant, dense color images can be produced with different Copyflex developers.

*Copyflex Opaque Cloths* are tough, durable, and provide highly workable surfaces for alterations with pencil or ink. Ideal for maps, plats, charts, and plans.

## BRUNING SENSITIZED TRANSLUCENT MATERIALS.

Here are the famous Copyflex intermediates with which you can make reproducible prints of originals to save up to 90% in tracing time in re-working originals.

*Copyflex Papers* are resin-transparentized sensitized mediums that provide a positive, reproducible image of all or any selected part of an original, a workable drawing surface for making design additions or alterations.

*Copyflex Cloths* make strong, permanent, and water-repellent "duplicate originals." Twin matte surfaces permit pencil or ink alterations to be made on either side.

*Copyflex Acetate Films* with matte finish or clear finish provide durable, waterproof, highly reproducible prints. Ideal for making design changes and composite prints. Different Copyflex developers can be used to produce brilliant colors for visual aid applications.

No other combination of reproduction materials and reproduction machines offers you so many ways to save time and money as does Copyflex. Get full information by mailing the coupon below.

**BRUNING** *Copyflex*

**Charles Bruning Company, Inc., Dept. 44-O**
**1800 Central Road, Mt. Prospect, Ill.**
Offices in Principal U. S. Cities
In Canada: 105 Church St., Toronto 1, Ont.

Please send me the free booklet on Copyflex machines and materials.

**Name** _____ **Title** _____

**Company** _____

**Address** _____

**City** _____ **County** _____ **State** _____

device in miniature amplifiers, servos, computer switching circuits and power supplies. Also, as a temperature-sensing element for automatic controls. **Texas Instruments, Inc., P. O. Box 312, Dallas, Tex.**

Circle 10, inside back cover

## Worm-gear speed reducers . . .

with ¼ to 5-hp input are carried in stock. Designed to combine max load-carrying capacity with min center distances. Four types, with worm at bottom, with worm at top, with low-base, vertical output shaft up and high-base vertical output shaft down, are offered in 2, 2⅜, 2⅞ and 3⅜-in. center distances. Each size is available in 10¼:1, 20½:1, 30:1, 40:1, 50:1 and 60:1 ratios. Virgin alloy bronze wide-faced worm gears are used; worm-gear shafts are drop-forged steel. Mating worm and shaft are alloy steel, carburized, hardened and ground. Housings are cast iron. Neoprene spring-backed lip seals are used. **Foote Bros. Gear & Machine Corp., 4545 S. Western Blvd., Chicago.**

Circle 11, inside back cover

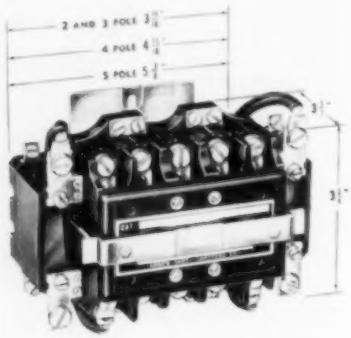
## Epoxy glass laminate . . .

G-11-861, retains 70 to 80% of its original flexural strength when tested at 300 C after conditioning for 1 hr at that temperature. Overcomes limitations of the G-10 type in applications requiring mechanical strength at elevated temperatures. Also supplied as copper-clad phenolite for printed-circuit applications. Bond strength is 10 to 15 lb, dip-solder resistance more than 30 sec at 500 F. This grade has gas-heat resistance at elevated temperatures, high mechanical strength, good electrical properties and dimensional stability. Both materials available in 39 x 47-in. and 39 x 39-in. sheets, 1/32 to ½ in. thick. Dark tan is the standard color for both materials in a dull finish. Tolerances are the same as NEMA G-10 and G-10 copper clad. **National Vulcanized Fibre Co., Box 311, Wilmington, Del.**

Circle 12, inside back cover

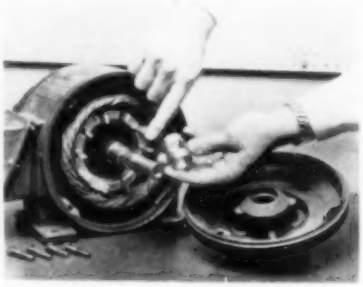
## 30-amp starters, contactors . . .

for motor control are supplied in two, three and four-pole models. Controls are designed for smaller size, straight-through wiring, extra wiring terminals. Quick-trip




or standard heaters can be furnished. Coil-wattage values for all models are 29 w inrush and 2 w sealed. Coils can be supplied for all standard voltages. Available as open units or equipped with NEMA Type I enclosures. Slotted mounting holes are provided. **Arrow-Hart & Hegeman Electric Co., 103 Hawthorne St., Hartford.**

Circle 13, inside back cover



## Sleeve-bearing ac motors . . .

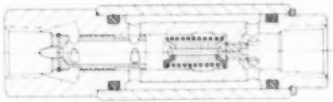
from ¾ through 15 hp are available in all standard enclosures for operation on standard NEMA voltages from 208 through 550 v. Bearing design employs a patented fluid-fiber material that combines with oil to form a fluid mass that is extruded into the bearing cavity. Tests indicate that it holds oil up to three times longer than felt wicking. Housing is cast-iron. Totally protected insulation system has coil heads and connections guarded against rough handling and abrasion. These polyphase motors can be mounted horizontally on wall, ceiling, floor or supporting deck. **Reliance Electric & Engineering Co., 24701 Euclid Ave., Cleveland 7.**

Circle 14, inside back cover

## Ceramic-magnet pulley . . .

is reported to equal the performance of electromagnetic types. Radial-pole design of the magnet assembly is said to boost holding efficiency without disadvantages of electric power supply. Available in standard widths from 12 in. up in 12, 15, 18, 20 and 24-in. dia. **Stearns Magnetic Products, 635 S. 28th St., Milwaukee 46.**

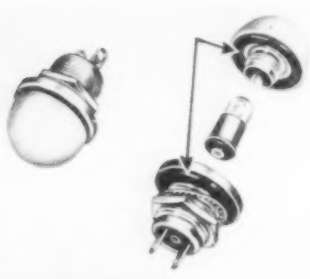
Circle 15, inside back cover



## Reverse flow check . . .

is for use as a pressure-compensated constant flow regulator in oil hydraulic circuits in which reverse flow of a larger volume than the regulated flow must be obtained at low pressure drop. Reverse flow is uncontrolled. The 1 to 10 gpm regulator is rated at 75 to 3000 psi differential. **Waterman Engineering Co., 725 Custer Ave., Evanston, Ill.**

Circle 16, inside back cover



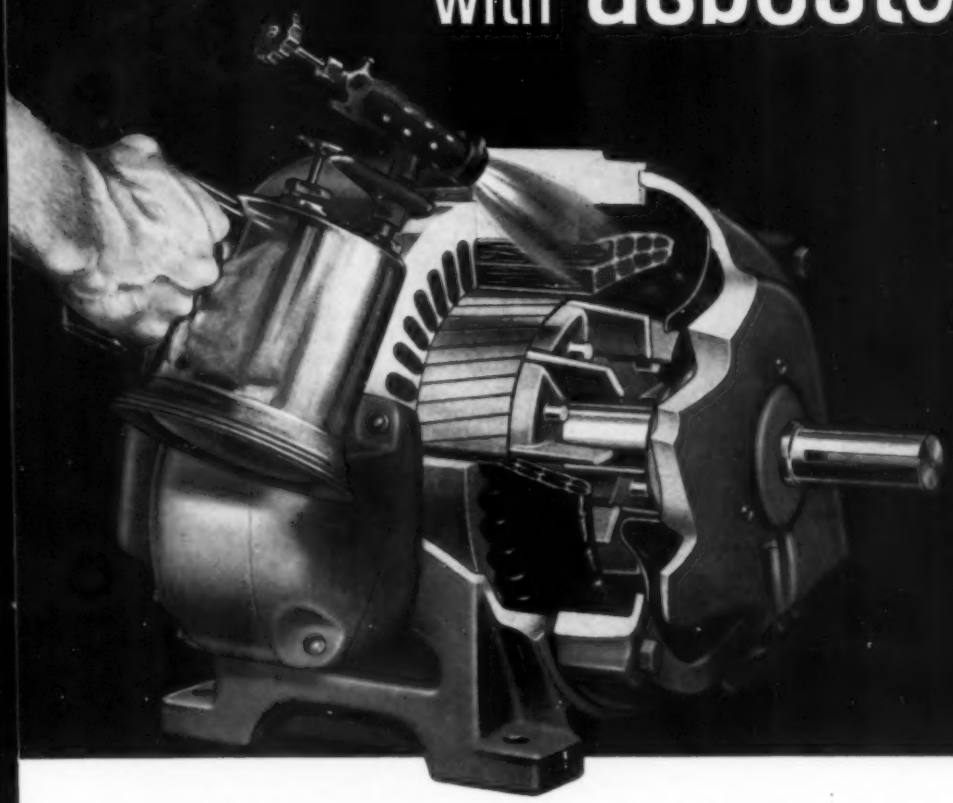
## Watertight indicator light . . .

for exposed panels contains two recessed rubber O-rings between lens cap and case and between mounting flange and panel.

CONTINUED ON PAGE 116

only **U.S. MOTORS**

# insulates all windings with asbestos!



*your best protection*

against
motor burn-out
and
production
shutdowns

Only U.S. offers this protection! ALL windings insulated with asbestos—nature's million-year-old insulating material that *cannot carbonize!* Many motor makers use varnished paper, cloth, oiled linen, press-board, fish-board—even insulating varnish alone. All these will carbonize... not one is fire-proof!

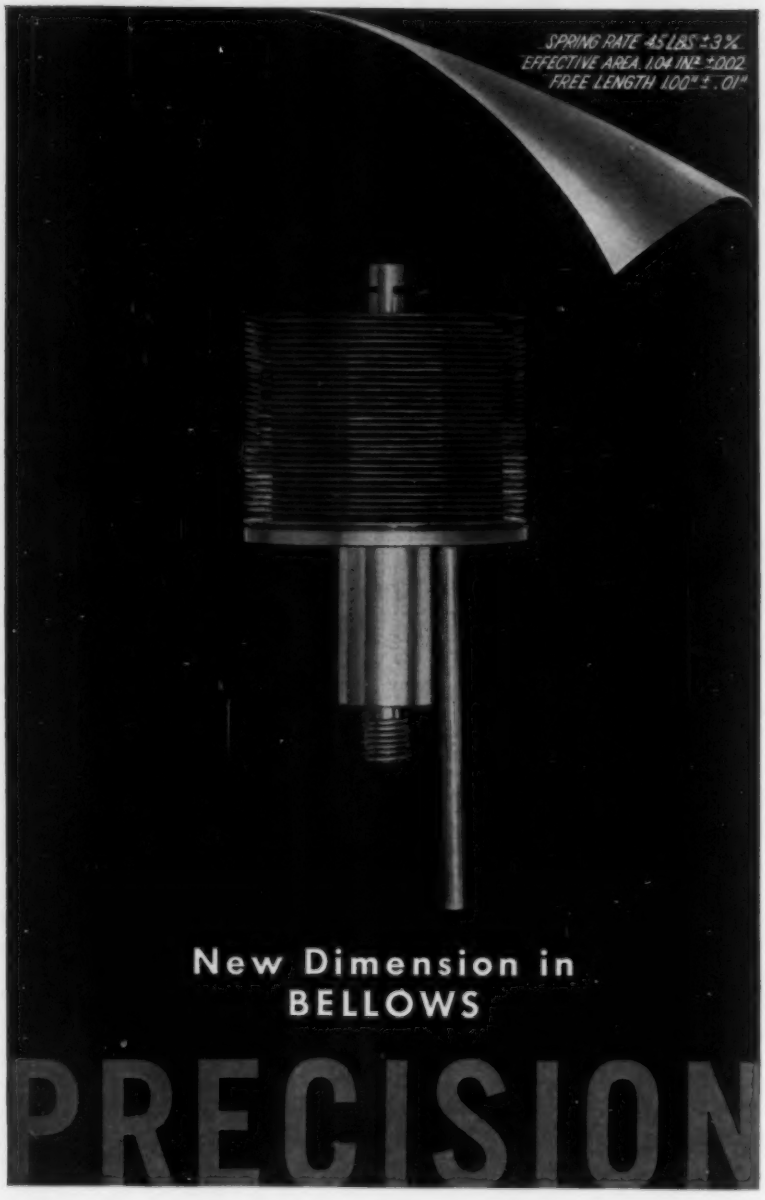
Only the original, patented U.S. ASBESTIC PROCESS—gives you: 1—*Heat resistance*... can't carbonize, 2—*heat conductance* better than any cellulose material, 3—*moisture resistance*... due to exceptional impregnation and coating of windings.

Protect yourself against costly production shutdowns due to motor burn-out! Be sure to specify: "U.S. MOTORS"!

## U.S. ELECTRICAL MOTORS INC.

BOX 2058, LOS ANGELES 54, CALIFORNIA
OR MILFORD, CONNECTICUT

*FREE COLOR-ILLUSTRATED BROCHURES*
*For specific data on asbestos protection, write for General and Type H Uniclosed Bulletins.*




When your specifications for design and manufacture of precision bellows require unusual know-how or close scheduling, Belfab Corporation may be your best source. Precision welded bellows by Belfab have helped solve many "impossible" problems—and almost literally helped develop new dimensions in bellows precision.

Preliminary designs, catalog and data sheets furnished on request without obligation.

THE BELFAB CORPORATION

AGAWAM, MASSACHUSETTS • DAYTONA BEACH, FLORIDA

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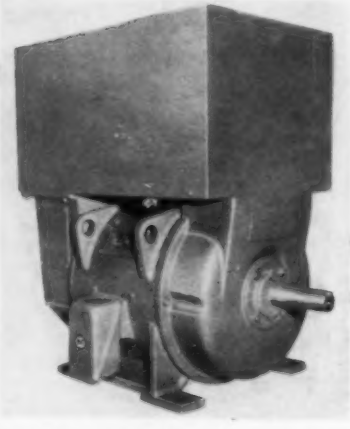
Insulation around large-arc center contact will not swell or cause jamming of the internal-contact loading-spring assembly. Units accommodate midget flange-base AN3140 lamps, available for 6, 14, or 28-v operation. Cases are corrosion-resistant, anodized aluminum. Over-all size is 1 9/16 in.; lights mount in ¼-in. panel hole. Available with lens caps in 10 transparent and translucent colors. **Hetherington, Inc., Folcroft, Penna.**

Circle 17, inside back cover

**Current-sensitive relay . . .** designed for operation in ac circuits detects loss of load. It may be utilized wherever the motor is normally loaded to 30% of rating and where loss of load must be detected for various reasons. Designed to become de-energized in the same manner that would occur if the load had fallen below preset level in the event of tube failure or relay-coil burnout. **Machinery Electrifications, Inc., 56 Hudson St., Northboro, Mass.**

Circle 18, inside back cover



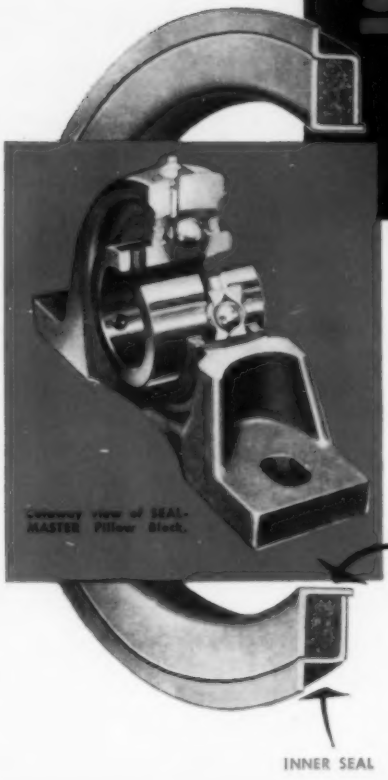
**Totally enclosed dc motors . . .** with self-contained heat-exchanger cooling for operation in highly contaminated atmospheres, are available in constant or

(Continued on page 120)

# SEALMASTER'S *Patented*

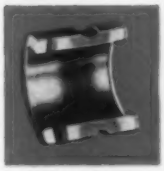
# LABYRINTH SEAL

**PREVENTS ENTRY OF DUST AND DIRT AND RETAINS PROPER AMOUNT OF LUBRICANT FOR LONG BEARING LIFE!**




Ability of SEALMASTER Ball Bearing Units to perform smoothly amid conditions of dust, dirt and grime, is largely due to the design of the Sealmaster patented Labyrinth Seal. Consisting of felt-lined steel flingers rotating in labyrinth, the SEALMASTER Seal prevents entry of dirt and dust into the bearing unit and retains the lubricant within the ball path area. A feature you will want in the bearing units you specify. Remember — there is only one SEALMASTER Seal — most copied because it's most effective.

## *PLUS* THIS EXCLUSIVE COMBINATION OF FEATURES!



**ZONE HARDENING** . . . assures positive race to shaft holding power. Reduces corrosion.

**LAND RIDDEN BALL RETAINER** . . . minimizes ball wear, traps grease and prevents "churning."

**LOCKING PIN & PERIMETER DIMPLE** . . . prevents rotation of outer race, assures positive lubrication.

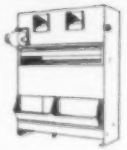
## KEEP 'EM ROLLING WITH SMOOTH PERFORMANCE AT EVERY TURN!

**MACHINE TOOLS**
SEALMASTER quality pays off where the trend is to continuous, fast, automatic equipment.

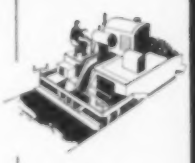
**TEXTILE INDUSTRY**
Clean, fast production is assured with SEALMASTER Bearings.

**FARM MACHINERY**
SEALMASTER Ball Bearing Units keep dust and dirt out, lubricant in—a feature Farm Machinery demands.

**CONVEYORS**
SEALMASTER Ball Bearing Units are featured by manufacturers of many types of conveyors.



**AIR CONDITIONING**
Quiet, trouble-free performance is assured with SEALMASTER. Find out about new rubber mounted units.



**CONSTRUCTION MACHINERY**
SEALMASTER Ball Bearing Units provide the features for gruelling performance in construction and materials handling equipment.

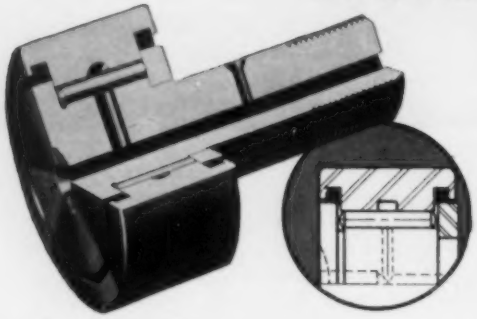
SEALMASTER®
BALL BEARING UNITS

*Write for Bulletin 454*

SEALMASTER BEARINGS A DIVISION OF STEPHENS-ADAMSON MFG. CO. 9 RIDGEWAY AVENUE, AURORA, ILL.

# BEARING TIPS by McGill

## sealed CAMROL® bearings lock out contamination in critical cam follower applications

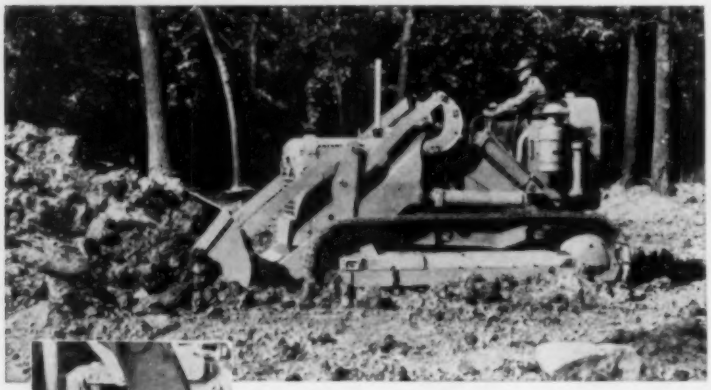


The new SCF series of the famous CAMROL cam follower completely seals out dirt, chips, moisture, etc. — an important advantage where the life of an ordinarily open mounted cam follower can be materially increased with adequate protection against contamination. Also the sealed bearing is pre-lubricated with provision made for easy re-lubrication, if desired, through either end of the stud.

Specially treated synthetic seals are contained in the outer race undercuts over the stud flange and roller retaining washer. For added protection, all external surfaces of the bearing are treated to provide a corrosion resistant, black ferrous oxide surface.

These same advantages are available in the SCYR sealed series Cam Yoke Roller (without stud). Specify CAMROL bearings with the built-in seals that preserve cam follower dependability in critical cam action, support or track roller application.

*Now Sealed and Prelubricated*



### Built-in seals protect and preserve CAMROL® bearings from contamination in CATERPILLAR-built TRAXCAVATORS®

McGill SCF series sealed CAMROL bearings provide the cam action that positions the bucket of the No. 977 Traxcavator unit at the selected digging angle. Mounted on bell crank arms that are actuated by contact with a cam shoe on a hydraulic cylinder linkage, these bearings are operating in the open and exposed constantly to dust, dirt and moisture. External surfaces have a black ferrous-oxide finish to prevent corrosion. These sealed McGill cam followers eliminate the need for relubrication and maintenance after installation. Caterpillar uses other McGill bearings including twelve CYR series cam yoke roller bearings in the flywheel clutch.

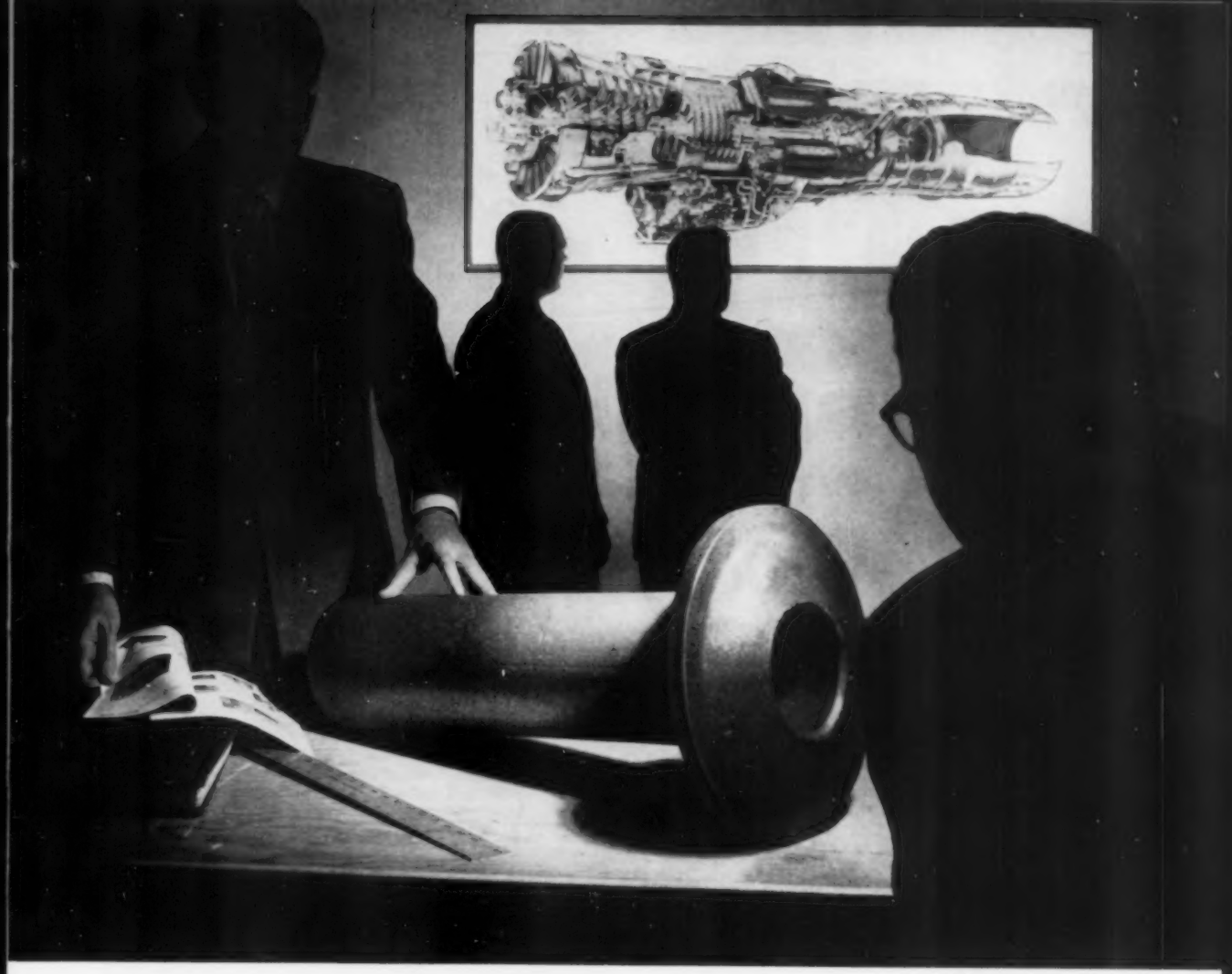
### 378 sealed CAMROL® bearings guide engine blocks in INGERSOLL automatic milling machine

The sealed CAMROL bearings used in this machine, guide cylinder blocks during transfer through various milling, boring and drilling operations. The bearings, used in place of guide bars, eliminate surface scratching of the 200 to 300 pound blocks which are transferred at speeds up to 400 feet per minute. Blocks are processed at the rate of 95 per hour. Ingersoll reports freer movement, accuracy of positioning and materially longer bearing life due to the new design that seals metal chips out of the bearings.

*Insure performance with* McGILL®

MULTIROL® GUIDEROL® CAMROL®
Precision Needle Bearings

**McGILL MANUFACTURING COMPANY, INC., 201 N. LAFAYETTE ST., VALPARAISO, INDIANA**



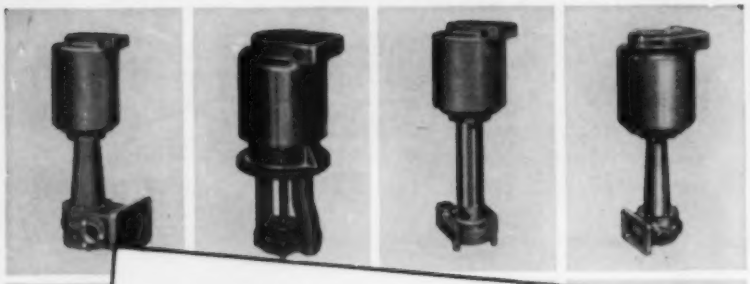
## NEW TWIST FOR JET TURBINE SHAFTS

Formerly many of these shafts were made from upset tubing. Almost any design engineer, production man or purchasing agent would say – this is it. But not the people in our forging department. They are always anxious to try for a better solution – a new twist – to even a simple problem.

As a result, Cameron now produces these shafts from specified billet stock in a one piece forged unit. The head is formed and the tube is extruded in a single operation. Metallurgy can be accurately controlled by our own high quality alloy steel production. Grain structure is perfect and the price, which has taken an interesting turn, is even lower than for the upset method.

Ferrous forgings from 8 lbs. to 8,000 lbs. in unusual shapes and in alloys for extreme service are our specialty. Cameron's split-die forging presses (largest in the world) have solved many problems in this field. For simpler shapes such as this jet turbine shaft, other Cameron presses are also adding a new, money saving twist to old techniques. Write, call or come by . . .

Cameron
IRON WORKS, INC.
SPECIAL PRODUCTS DEPARTMENT
P. O. Box 1212, Houston, Texas



There's a

**GUSHER**

**COOLANT PUMP TO FIT EVERY REQUIREMENT**

Inside, outside, flange mounted, immersed type, pipe connected, and tank units . . . you name it . . . we have it. Choose the make and model GUSHER PUMP that best fits your application.

. . . and remember, GUSHER Sealess PUMPS are of advanced design, precision built and electronically balanced. You get long life . . . efficient operation. Write for catalog *today*.

Also available our Rumaco line of self adjusting seal pumps for installations requiring a seal and GUSHER Molten Metal Pumps.

THE Ruthman MACHINERY CO.

• COOLANT PUMPS
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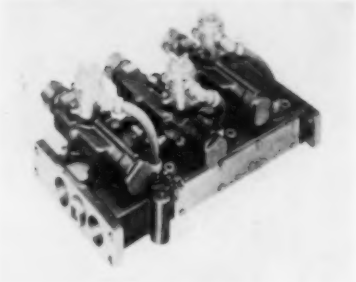
1811 Reading Road Cincinnati, Ohio

adjustable speeds from 10 through 200 hp. Independent cooling system is unaffected by motor speed, and a thermostatic relay in the hot-air stream at commutator end shuts down drive or operates an alarm in case of blower failure. Separate conduit boxes are provided for dc motor and heat-exchanger units. Permits top, sidewall or ceiling mounting. Designed for machine-tool, steel-mill drive and other applications. **Allis-Chalmers Mfg. Co., Milwaukee 1.**

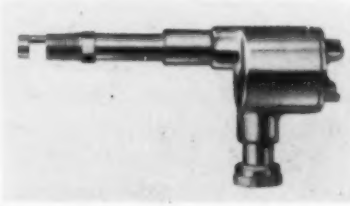
Circle 19, inside back cover



## Deceleration manifold . . .

controls large double-acting cylinders on automated equipment requiring rapid movement as well as controllable cushioning at any point in either or both strokes of cylinder. Unit consists of two three-way, solenoid-actuated pilot-operated valves and one threeway, directional flow valve (actuated by limit switches) mounted on a special cast aluminum manifold. Preassembled unit has full-length conduit passage for electrical wiring, with a removable cover for access. Inlet, exhaust and wiring passages all are 1¼ in. NPT. Either ¾ or 1 in. NPT port size is optional. **Valvair Corp., 454 Morgan Ave., Akron 11, Ohio.**

Circle 20, inside back cover



## Liquid-level sensor . . .

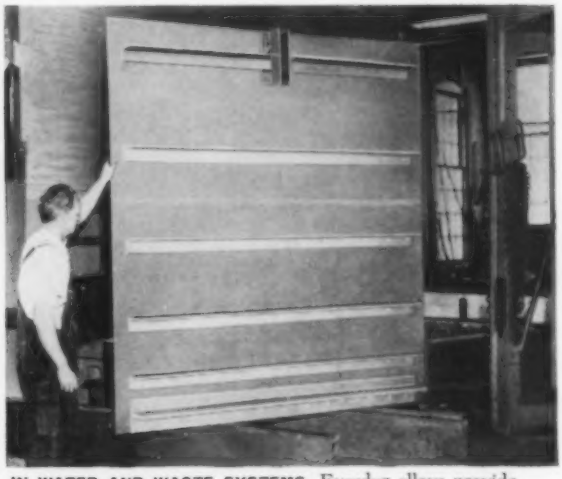
uses radioactive material in sensing element. Said to operate with accuracy of 0.05 to 0.10 in. of required level in water, acids, alkalies, oils and viscous liquid. Unit consists of a small sensing probe, mountable in any position, that can be connected by up to 200 ft of cable to an amplifier. A relay in amplifier operates remote warning devices or motor starters, valves, timing devices and other

(Continued on page 122)

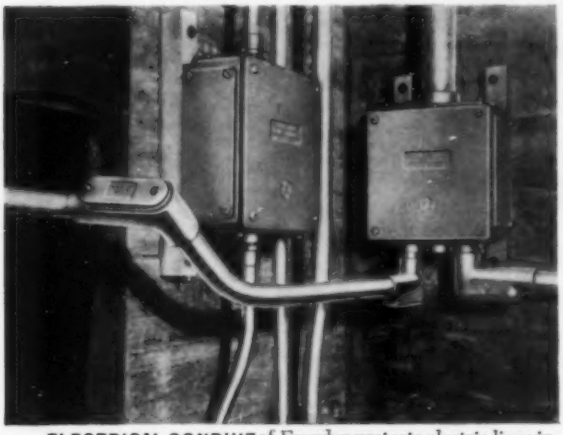
# CUT CORROSION LOSSES

## Get unusual corrosion resistance, plus high strength, toughness, weldability, and easy fabrication with Everdur,® Anaconda copper-silicon alloys

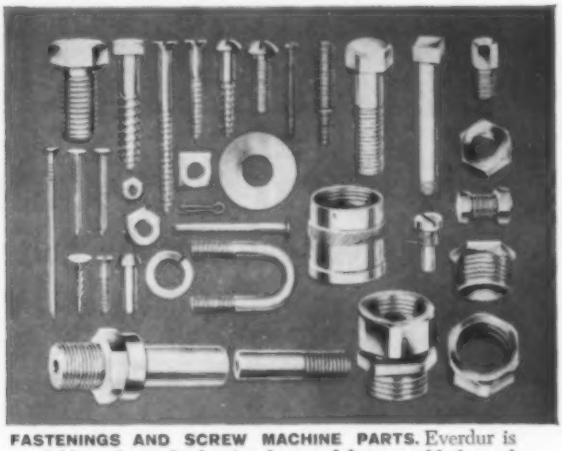
**TANKS AND INDUSTRIAL EQUIPMENT** requiring a combination of high strength, toughness and resistance to corrosion. Hot water storage heaters and tanks, unfired pressure vessels of Everdur are readily fabricated by welding.



**IN WATER AND WASTE SYSTEMS,** Everdur alloys provide easy fabrication and long service in a wide variety of jobs—from gates on to bolts and nuts. Their high strength makes possible lightweight, built-up assemblies of wrought metal.



**ELECTRICAL CONDUIT** of Everdur protects electric lines in corrosive environments, withstands vibration and abrasion —at oil refineries, in underwater tunnels (above), chemical plants. Made in two wall thicknesses—R.C. and E.M.T.



**FASTENINGS AND SCREW MACHINE PARTS.** Everdur is available in forms for hot heading and forging of bolts and accessories, severe cold-working operations for bolts and screws—and as free-cutting rod for screw machine products.

Whenever you have a tough problem calling for high strength with immunity to rust, and corrosion resistance equivalent to pure copper, consider an Everdur alloy. It may save you a lot of trouble and money. For details on properties and applications of Everdur alloys, write for Publication E-5. Address: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

**EVERDUR**

**COPPER-SILICON ALLOYS**

*products of*

ANACONDA®

*Made by The American Brass Company*

PLUS
protection
against
overload

Maxitorq

overload release clutches

Designers and builders have found MAXITORQ Overload Release Clutches the ideal way to provide dependable protection against overload conditions.

Unlike such devices as shear pins, the MAXITORQ Overload Release Clutch requires no dis-assembly or replacement after functioning. Once the cause of overload is removed or corrected, the machine may be re-started at once. Furthermore, MAXITORQ Overload Release Clutches may be adjusted for pre-determined overload protection.

In addition, users enjoy the proved advantages of the MAXITORQ Floating Disc Clutch . . . smooth, positive engagement and release . . . "floating" neutral with no drag or heating . . . easy manual adjustment.

We will be glad to give you the benefit of our long and successful experience in clutch and brake design; the overload release clutches are only one of many advanced MAXITORQ developments in both manual and electrically operated applications. Ask for literature, or outline your problem . . . write Dept. PE-4

THE CARLYLE JOHNSON MACHINE CO.
Manchester, Connecticut

2CJ58



mechanisms that may be used to maintain a desired liquid level. Unit is factory calibrated. Enclosures for general-purpose use, for Class II, groups E, F and G hazardous locations, for weather-resistance and for Class I, groups C and D and Class II, E, F and G are offered. Operates on 105 to 125 v ac, 60 cps, in temperatures ranging from —65 to 220 F for the probe to 0 to 135 F for the amplifier. Probe operating pressure ranges from vacuum to 800 psig max. **Robertshaw-Fulton Controls Co., 401 N. Manchester, Anaheim, Calif.**

Circle 21, inside back cover

## Web guide . . .

is controlled by a hydraulic relay that operates on hydraulic-jet principle with sealed and pressurized hydraulic circuit, 50 to 750 psi, which permits installation of relay in any position or location with respect to hydraulic pump and reservoir. Two internal parts, which may be varied, determine volume output of the relay. Controls without contact a variety of materials from polyethylene films to steel strip. A constant-pressure stream of air passing across a gap impinges on a receiving opening connected to outside of regulator diaphragm. Position-correction occurs whenever a web edge moves through gap. If edge is out of balance, relay is actuated and hydraulic piston moves reel or roll to correct error. **North American Mfg. Co., 4455 E. 71st St., Cleveland 5.**

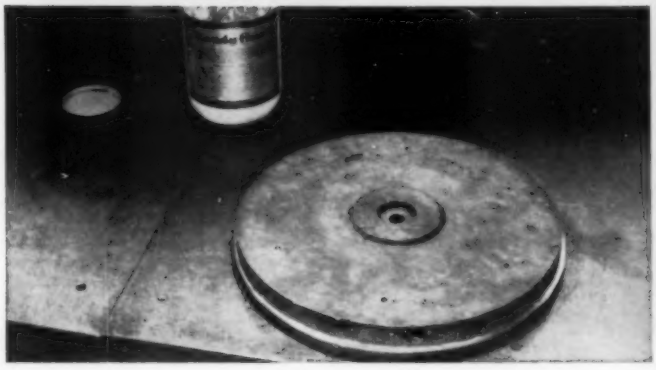
Circle 22, inside back cover

## Remote indicator . . .

meters flow rate, speed or position. When used with a shaft-mounted gear motor, it provides remote or automatic control for valves, variable-speed drives and a variety of other machinery. A potentiometer built into gearmotor provides position indication registered on meter. May also be used with any other positioning device that incorporates or drives a potentiometer. Provides indication by a milliameter calibrated from 0 to 100 with a linear response to

(Continued on page 124)

Insert halves are first carefully cleaned and fluxed. The sheet of EASY-FLO, .005" thick, in three sections, is liberally fluxed with HANDY FLUX. Following this, the halves are put together with EASY-FLO as a "sandwich filler" (below, left). Entire assembly is heated to a brazing temperature of 1170° F.



# How EASY FLO Helps COLUMBIA RECORDS make records

EASY-FLO is put to excellent use in the die inserts (or backing plates) used in the manufacture of Columbia Records at the company's Bridgeport, Connecticut, plant. These die inserts are the heating and cooling elements used in the actual plastic record molding; in a very real sense, they are *behind* the entire record-making operation. The die insert assembly consists of two steel plates, the bottom plate being grooved to permit the passage of steam, at a temperature of 300° F under a pressure of 130 lb., followed by cold water at a pressure of 120 lb. When joined, they must be absolutely leak-tight and strong enough to stand up under thousands and thousands of stampings through drastic temperature changes and thermal shock.

These brazed backing plates have a life cycle of some 250,000 records; they are usually retired because of warpage in the steel, rarely for joint leakage.

This example illustrates just a few of the qualities that make silver brazing such a superior joining method. Strength under high pressure, resistance to temperature changes and thermal shock, and production ease; one, or all, of these qualities may apply to your product or production operation. We will be happy indeed to show you how you can benefit from this blue-ribbon method of joining all kinds, shapes and sizes of metals—similar and dissimilar. BULLETIN No. 20 will get you off to a good start on the values, techniques and economies of low-temperature silver brazing. Write for your copy.

**Your NO. 1 Source of Supply and Authority on Silver Brazing Alloys**

**HANDY & HARMAN**

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MONTREAL, CANADA

*General Offices: 82 Fulton St., New York 38, N. Y.*

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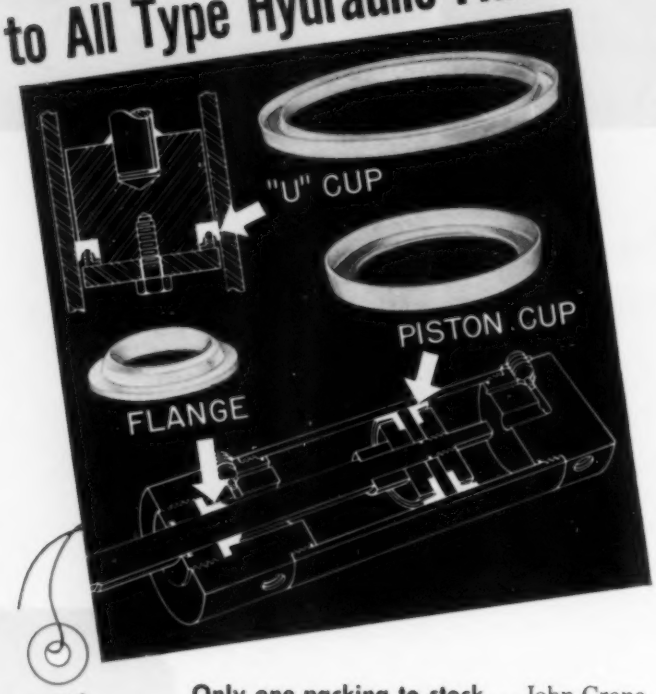
# CHEMLON® ...the one Packing Solution to All Type Hydraulic Fluids




**FOR ALL HYDRAULIC FLUIDS:**
PHOSPHATE ESTER
GLYCOLS
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WATER EMULSIONS
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ALL OTHERS

**Only one packing to stock** . . . John Crane Chemlon Piston Cup, U-Cup and Flange Packings are the answer to handling *all* types of hydraulic fluids. Machined from chemically inert Teflon,* they give positive sealing and long-lasting performance not possible with leather, fabric-reinforced or similar packings.

Heat will not cause these packings to shrink away from the cylinder walls or rod. They will not harden, shrink, swell or in any way disintegrate under higher temperatures often encountered in hydraulic service. Their exceptional thermal characteristics provide an operating range from −94°F. to +350°F.

Here . . . in a wide range of sizes or fabricated to your individual specifications . . . is a complete line of hydraulic packings to meet the need of any operating requirement.

**Write to "John Crane"** Send now for bulletin giving full technical and application data. Crane Packing Company, 6445 Oakton Street, Morton Grove, Illinois, (Chicago Suburb). *In Canada, Crane Packing Co., Ltd., Hamilton, Ont.*

*DuPont Trademark

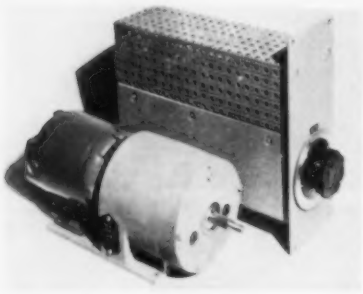
John Crane
MECHANICAL PACKINGS · SHAFT SEALS · TEFLON PRODUCTS · LAPPING MACHINES · THREAD COMPOUNDS

**CRANE PACKING COMPANY**




valve or drive setting. Accuracy extends to zero. Standard units are furnished in NEMA 1 enclosures for panel or base mounting. **Jordan Co., Inc., 3235 W. Hampton Ave., Milwaukee 9.**

Circle 23, inside back cover



## Remote-control system . . .

is designed for industrial applications requiring fast response, high output torque and accuracy. Consists of a combined controller-amplifier and a servo drive. Output shaft, driven by a magnetic-powder clutch, follows movement of the manual control with accuracies better than 0.25°. At max excitation, servo output torque is 250 in.-lb. High gain and low-inertia drive permit the system to reach max speed in 0.020 sec. **Lear, Inc., P.O. Box 688, Grand Rapids, Mich.**

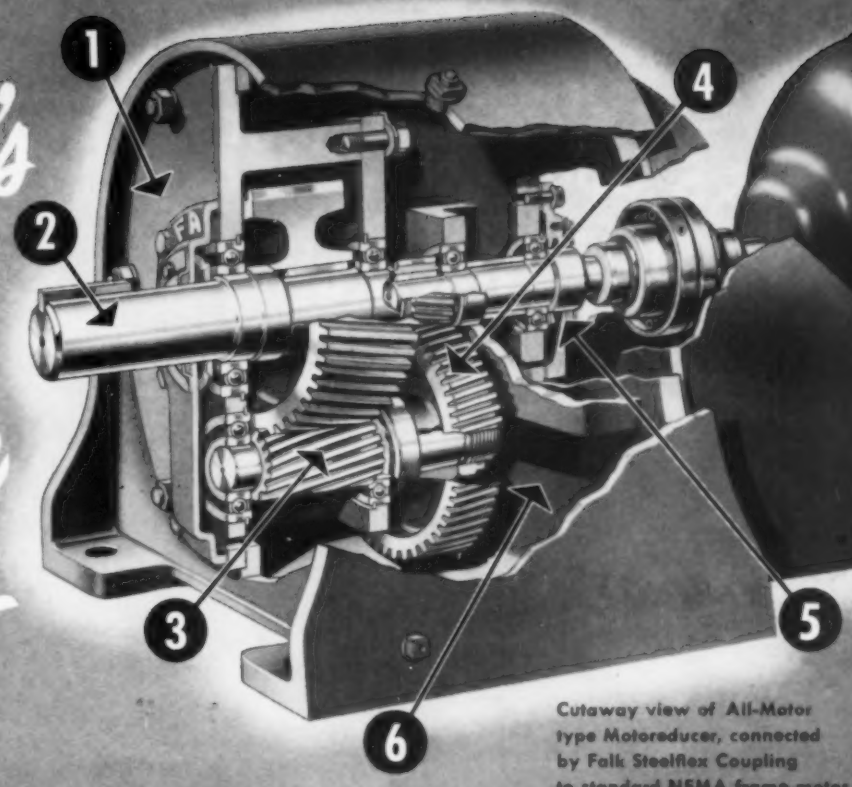
Circle 24, inside back cover

## Pneumatic poppet valve . . .

is a lightweight, small unit for applications where a min operating pressure of 10 psig exists and uniform timing is 5 sec max. The two-position valve is available in several sizes with various mounting provisions and flange details. Solenoid of 400 cps or standard 26 v dc solenoid may be used. External leakage for 2-in. valve, closed, is 0.02 lb. per min at 150 psig and 600 F. Ambient-temperature range is −65 to 300 F, continuous duty; maximum operating temperature is 600 F

**(Continued on page 126)**

# Here's the inside story—




Cutaway view of All-Motor type Motoreducer, connected by Falk Steelflex Coupling to standard NEMA frame motor

## WHY Falk Motoreducers give better service—have longer life

Here is the "inside story" behind the all-steel All-Motor type FALK Motoreducer's universal reputation as a gear drive unmatched in quality, efficiency, dependability, ease of maintenance and long life. These "In-built" factors are—

1 **ALL-STEEL HOUSINGS.** Rugged, strong, rigid...all parts are manufactured from heavy steel plate, formed and welded in the Falk Weld Shop.

2 **LARGE OVERHUNG LOAD CAPACITY.** Large shafts, oversize bearings...rigid mountings with wide bearing spans to handle maximum applied loads.

3 **PRECISION GEARING.** Heat-treated alloy steel gearing, precision cut and shaved after heat treatment to eliminate distortion. Quiet, crown-shaved pinions.

4 **EXTRA-CAPACITY GEARING.** Special extra-capacity gear-tooth form with larger contact area gives greater strength, higher load-carrying capacity.

5 **SEALED HOUSINGS.** Splashproof, dustproof, oil-tight construction. Dual closures and one-way vents keep oil in, dust and moisture out.

6 **POSITIVE LUBRICATION.** Large sump capacity...oiltight construction assures clean lubricant...revolving elements lubricated by direct dip.

When you buy or specify the All-Motor type FALK Motoreducer, you get all these—plus the tremendous advantage of full interchangeability of motors. Switch motors as desired—use any make, style or type of standard foot-mounted motor within the unit's AGMA rating—with a minimum of difficulty or "down time."

Available in sizes up to 75 hp—*with or without motor*—from convenient factory, field or distributor stocks, from coast to coast. **Write for Bulletin 3100.**

### 60,000 HOURS WITHOUT A FAILURE!

Sixty thousand hours is a lot of hours—but the FALK Motoreducer in the unretouched photo above has served that long without failure or need of repair.

This 3 hp unit is one of over 60 FALK Motoreducers in daily service in an Eastern plant of a large milling company, whose president says, in part:

"One of the main advantages of FALK Motoreducers is their adaptability to any motor. Reducers and motors can be easily interchanged....Our service records confirm the wisdom of our choice of FALK equipment as our standard."

**FALK** ...a good name in industry

**THE FALK CORPORATION, MILWAUKEE, WISCONSIN**

**MANUFACTURERS OF**

- Motoreducers
- Speed Reducers
- Flexible Couplings
- Shaft Mounted Drives
- High Speed Drives
- Special Gear Drives
- Single Helical Gears
- Herringbone Gears
- Marine Drives
- Steel Castings
- Weldments
- Contract Machining

Wide range of large

# H&S Speed Reducers

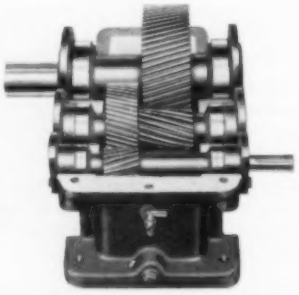
meets needs of

# Webster Car Pullers

Here's a job that calls for rugged power and dependable gearing — pulling fourteen 75-ton railroad cars along a straight track, up a 1% grade, at a speed of 40 ft. per minute.

Webster Manufacturing, Inc., Tiffin, Ohio, easily solved this problem with the construction of a 50 HP Webster Car Mover. As part of this unit, Webster selected a Horsburgh & Scott Helical Gear Speed Reducer because it provided the necessary stamina for this high-torque job . . . unusually heavy bearings to withstand the greater overhung loads incident to car-puller operation.

From the same source — Horsburgh & Scott — Webster obtains the necessary extra heavy machine cut spur gears that drive the cable drum.



Seventy years of experience prove that *rugged construction* and *ample overload capacity* of H & S products assure trouble-free service and operating economy. Send us your requirements or contact your nearby H & S representative for prompt recommendations.

**THE HORSBURGH & SCOTT CO.**

**GEARS AND SPEED REDUCERS**

5112 Hamilton Avenue

Cleveland 14, Ohio



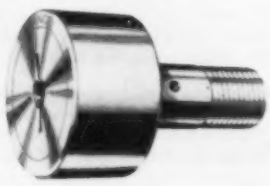

Valve is especially useful in applications requiring closure on either power or pneumatic failure. **Barber-Colman Co., Rockford, Ill.**

Circle 25, inside back cover

## Double-acting cylinders . . .

for service at 250 psi air are available in four models, which in turn are offered in four sizes. Horizontal, vertical, pivot or face-mounted models come with bores of 1½, 2½, 3¼ and 4 in. Basic cylinders are alike, but mountings are interchangable. All have internal cushioning at both ends, but can be converted to noncushioned cylinders by removing the cushion adjustment screws. Ram bearing surface is claimed to be greater than that in most existing equipment. End caps of horizontal models can be rotated to place the air inlets at any side desired. **Mead Specialties Co., AC-44, 4114, N. Knox Ave., Chicago 41.**

Circle 26, inside back cover

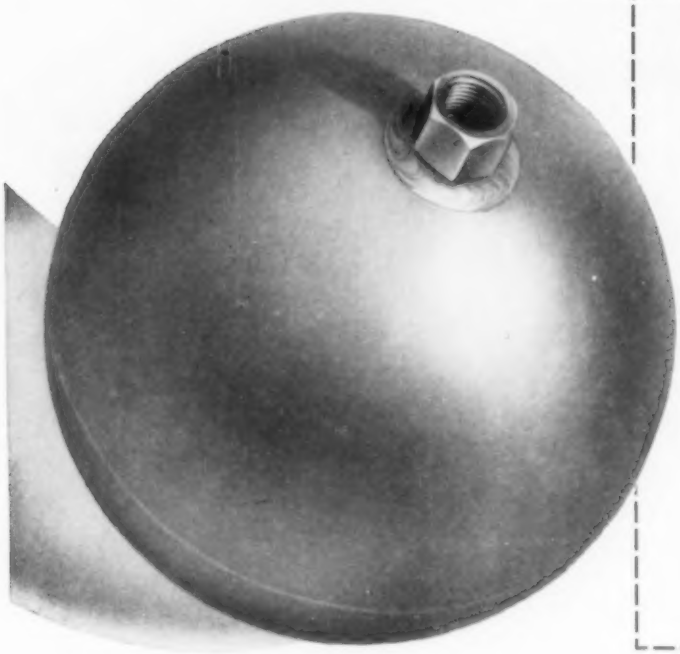


## Cam follower . . .

roller bearings provide high radial load-carrying capacity and shock resistance for cam-activated and similar mechanisms. Heavy-sectioned outer races are hardened-and-ground bearing steel. Available in standard studs, induction heat-treated for

(Continued on page 128)

# need floats?



**Name the way you want them!**

MATERIAL_____
SHAPE_____
SIZE_____
PRESSURE_____
QUANTITY_____
MORE INFO_____

*Your Name*_____
*Title*_____
*Company*_____
*Address*_____

*See below for details*
**Fill in blanks, tear out, and mail to:**
**W. H. NICHOLSON and COMPANY**
**Wilkes-Barre, Pa.**

Nicholson can deliver precision welded floats —made to your specifications—to fit your production schedule. Use the above form to tell us how you want them.

Here are the standard specs:

- **MATERIAL**—steel floats with chromium, cadmium or copper plating—with sandblast or pickled finish ... stainless steel and Monel floats—rough-buffed, polished or with welds ground smooth and highly finished.
- **SHAPE**—spherical, elliptical, cylindrical.
- **SIZE**—from 2 inches to 14 inches diameter.
- **PRESSURE**—from vacuum to 4800 lbs.
- **QUANTITY**—as many as you need.

These high tensile strength floats have exceptional resistance to pressure and corrosion. Float halves are die-formed, with inward rolled edges—not spun, laminated or electrodeposited.

Today, thousands of Nicholson floats are in service—most as buoyancy mediums . . . many as fluid chambers and pressure vessels. Write for details about the full Nicholson line.

W. H. NICHOLSON AND COMPANY, 12 OREGON ST., WILKES-BARRE, PA., *Sales and Engineering offices in 98 principal cities.*

**NICHOLSON**
***of Wilkes-Barre***

**H MICRO SWITCH** Precision Switches

# A NEW HONEYWELL MERCURY SWITCH

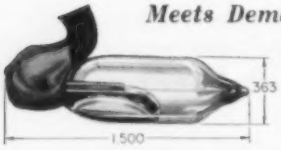
*Sealed Within Nylon Enclosure*
•
*Shock-Proof*
•
*Resistant to Oil and Water*

7MP1-2 Actual Size

*Cut-away view showing switch embedded in synthetic rubber within the nylon enclosure.*

This NEW mercury switch is resistant to shock, vibration, water, alkalis and oils. Operates completely immersed. Operates at temperatures of from −35° to +200°F. Rated 3 amps., 115 vac. *For complete details send for Data Sheet #144.*

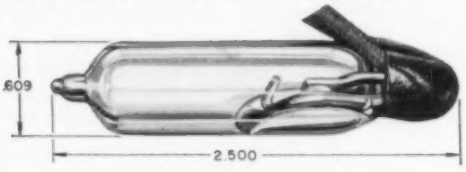
***Meets Demand for Small Load Circuits***




AS417B
Actual Size

This small Honeywell Mercury Switch meets the demand for small load circuits and applications where space is a factor. Serves in a range from micro-volt milli-ampere up to 3 ampere circuits. *Full details in Data Sheet #114.*

***Here is a General Purpose Mercury Switch***




AS454A Actual Size

This is a medium size, general purpose mercury switch for loads up to 10 amps., 115 vac. Whenever your requirements call for general advantages such as sealed contacts and low force tilt action, this is the switch for you.

*Ask for Catalog #90A.*

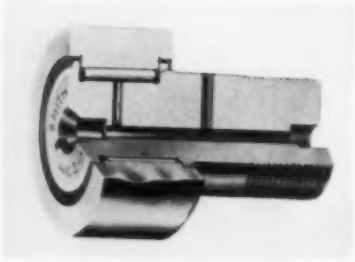
**MICRO SWITCH**
A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY
In Canada: Leaside, Toronto 17, Ontario • FREEPORT, ILLINOIS

*First in Precision Switching*




max hardness of roller track. Conventional passages are for use with drive-type fittings or may be sealed with plugs furnished. Choice of 22 standard sizes from ½ to 4 in. OD in steel, chrome and cadmium plating or black oxide finish. Small-dia rollers are electronically gaged for uniformity of size. **Orange Roller Bearing Co., Inc., 557 Main St., Orange, N. J.**

Circle 27, inside back cover



## Nylon-sealed cam followers . . .

keep out dust, grit and other abrasives. Made to standard dimensions. Said to have minimum friction. Heavy-duty type shown. **Smith Bearing Co., P. O. Box 1119, Station D, Trenton, N. J.**

Circle 28, inside back cover

## Hydraulic relief valves . . .

are for inline use, conforming to military specifications. A special compensating design feature allows use of extended flow rates, as high as 4.5 times rated flow without exceeding allowable pressure differential. All valves qualify for operation in temperatures from −65 to 275 F. Adjustments for max pressure settings range from 300 to 3850 psi, and can be made available to 4850 psi. Available from stock in ¼, ⅜ and ½-in. tube sizes. **Pacific Div., Bendix Aviation Corp., 11600 Sherman Way, N. Hollywood, Calif.**

Circle 29, inside back cover

## PVC ball valve . . .

is self-lubricating. Provides take-up to compensate for wear. Straight-through, full-open port design permits full flow without turbulence or directional change. Ball floats in chamber. Teflon seats do not

(Continued on page 130)

**Other Outstanding Shell Industrial Lubricants**

**Shell Tellus Oils**—for closed hydraulic systems

**Shell Talona R Oil 40**—anti-wear crankcase oil for diesel locomotives

**Shell Rimula Oils**—for heavy-duty diesel engines

**Shell Turbo Oils**—for utility, industrial and marine turbines

**Shell Alvania Grease**—multi-purpose industrial grease

**Shell Macoma Oils**—for extreme pressure industrial gear lubrication

**Shell Voluta Oils**—for high-speed quenching with maximum stability

## Its performance and name are the same around the world

Shell Dromus Oils are a quality line of soluble cutting oils that permit higher speeds and greater feeds while extending tool life. They have excellent wetting and cooling properties and are not sticky or greasy.

Dromus* Oils have the added advantage of being easy to mix in hot or cold, hard or soft water. They form emulsions which remain stable in any concentration required in the shop.

When your machine tool customers abroad specify Dromus Oil, they will enjoy the same efficient performance your domestic customers rely upon.

For more information, write Shell Oil Company, 50 West 50th Street, New York 20, New York, or 100 Bush Street, San Francisco 6, California.

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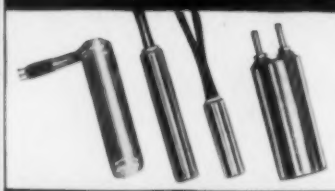
SHELL

Solve Your
**HOT PROBLEMS**
*with*

**VULCAN VERSATILITY**



**IN CARTRIDGE HEATERS**

Vulcan Electric Cartridge Heaters are especially designed for insertion into machine parts, dies, platens, molds, presses, die blocks of embossing machines, packaging machines, etc.

You have a wide choice of standard sizes — from 1″ to 25″ (or longer); diameter — ¼″ to 1 1⁵⁄₁₆″ (or greater); wattage — 10 to 3200 (or higher); voltage — standard 120 or 240, special 6 volts up; sheath — brass, steel, nickel or high temperature alloys; standard or special lead wires or terminals.

When your hot problems call for unusual specifications, you get a speedy solution through *Vulcan Versatility* — in design, engineering and production. Standard or special, Vulcan is ready to supply your complete needs in low cost, efficient heating units. Send coupon for Catalog and prices.

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VULCAN ELECTRIC COMPANY
Danvers 18, Mass.

Please send me catalog and price information on Vulcan Electric Heaters. I am especially interested in (check)

☐ Cartridge ☐ Tubular
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NAME & TITLE.....
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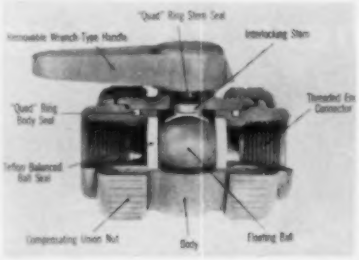
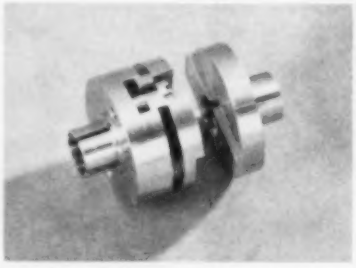
CITY & STATE.....




stick nor gall. Available in threaded or socket ends for installation with solvent cement. Valve has no metal parts. Recommended working pressures for ½ through 1½-in. valves are 140 psi at 100 F; 70 psi at 130 F. For 2 and 3-in. sizes, to 100 psi at 100 F; 50 psi at 130 F. **Plastics Div., B. F. Goodrich Industrial Products Co., Marietta, Ohio.**

Circle 30, inside back cover



## Oldham-type coupling . . .

applicable in servo transmissions and similar drives where relatively high torques are involved. Couplings consist basically, of two male hubs fastened to shafts, and a floating, female center section. A female connecting portion is permanently attached to one of male sections to simplify assembly. Coupling surfaces are hand-lapped to obtain min backlash and uniform contact. **Sterling Precision Corp., Instrument Div., 17 Matinecock Ave., Port Washington, N. Y.**

Circle 31, inside back cover

## Molded hydraulic seal . . .

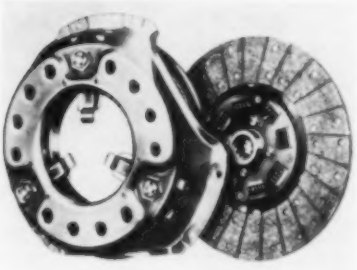
is jointless and said to be impervious to water, oil and oil solvents. The single ring seal has a flared lip construction to seal even at low pressure and to withstand hydraulic shock without distortion. No adapters or reinforcements are neces-

(Continued on page 131)

Servospeed
HEART OF AUTOMATION
MODERN ELECTRONIC ENGINEERING GIVES PRECISE MOTOR SPEED CONTROL
1/100 — 10 H. P.
Modern industrial electronic engineering has been coordinated with electric motor design to provide a versatile means for obtaining the full possible advantage of speed control in DC motors while operated from the regular alternating current power line. Grid controlled "Thyratron" tubes are utilized for power controlled stepless variation to supply motor armature power. Patented feedback, or "Servo" circuits provide constant torque capability over wide speed ranges of as high as 60 to 1 in some models and a minimum of 20 to 1 in others.
Servospeed
DIV. of ELECTRO DEVICES, Inc.
4 Godwin Ave., Paterson, N. J.
ARmory 4-8989

sary. Gland pressure or adjustments are not required. Can be installed in any-depth stuffing box from 1½ in. up. Coating of fabric prevents packing swelling and binding of ram. Operates at any hydraulic pressure. **A. W. Chesterton Co., Everett 49, Mass.**

Circle 32, inside back cover



## Direct-pressure clutches . . .

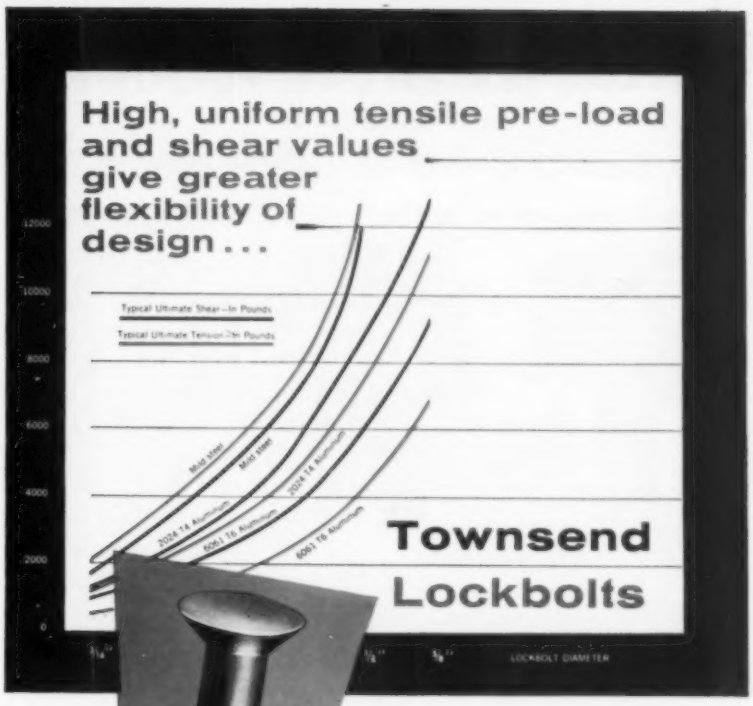
for heavy-duty service for truck, tractor and industrial use are rated for engines to 300 ft-lb gross torque. Single plate unit 12-in., is a dry-disk clutch. Chrome-silicon cylindrical pressure springs and insulating washers are used. Non-warping pressure plate is of chrome-molybdenum iron. Stamped-steel cover is ventilated. Facing area is 115.4 sq in. with a unit pressure up to 27.8 psi. Clutch has a max release bearing load of 464 lb at full release. **Lipe-Rollway Corp., Clutch Div., 806 Emerson Ave., Syracuse 1, N. Y.**

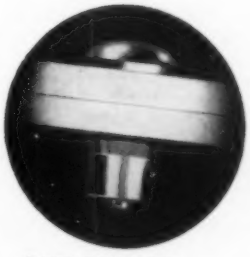
Circle 33, inside back cover

## Measures load . . .

on any machine-tool operation. Gives visual tool-wear indication and monitors tool wear and machine-operating condition. Unit reveals even slight increases or decreases in power consumption. The dual-purpose instrument may be set to monitor only wear or machine-tool overload or underload. Made in amperage ranges up to 300 ac. Standard stocked ranges are 10 to 50 and 40 to 150 amp. Other amper-

(Continued on page 132)



Townsend lockbolts* give the designer great flexibility, for they may be used in either shear or tension applications, and have great resistance to fatigue. A high tensile pre-load is imparted to the joint during installation, which gives a very high shear value. No over-design is necessary, because shear and tensile pre-load values are the same in every joint.

The setting gun swages the collar to the locking grooves on the pin, and breaks off the projecting pin tail as a pre-determined break-load is reached. The gun's cycling action cannot be altered, and even men with no special skill can produce strong, uniform, economical joints.

For more information on Townsend lockbolts, request a complete demonstration right at your desk, or write for Bulletin TL-101. Townsend Company, P. O. Box 237-D, New Brighton, Pa.

*Licensed under Huck patents RE 22,792; 2,114,493; 2,527,307; 2,531,046; 2,531,040 and 2,754,703

The Fastening Authority

**Townsend**

COMPANY • ESTABLISHED 1816

NEW BRIGHTON, PENNSYLVANIA

Sales Offices in Principal Cities

Cherry Rivet Division • Santa Ana, California

NOW

**NYLON SEALED CAM FOLLOWERS**

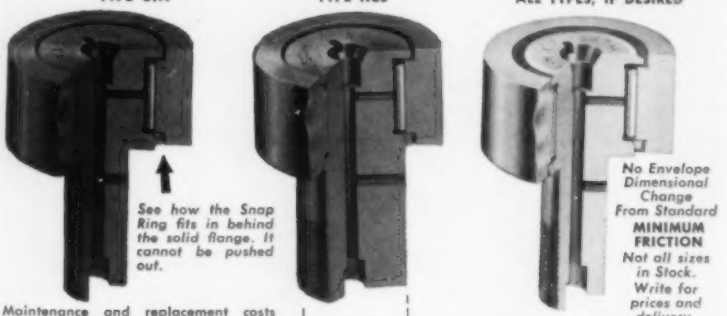
Added To The

**COMPLETE LINE OF SMITH BEARINGS**

STANDARD INTERCHANGEABLE TYPE CTA

HIGH CAPACITY TYPE HCS

NYLON SEALED ALL TYPES, IF DESIRED


See how the Snap Ring fits in behind the solid flange. It cannot be pushed out.
No Envelope Dimensional Change From Standard
MINIMUM FRICTION
Not all sizes in Stock. Write for prices and delivery.

Maintenance and replacement costs are greatly reduced by the patented snap ring feature. High Capacity has large diameter stud EXCLUSIVE with Smith. Cam Yoke and Standard Cam Follower interchangeable with other lines.

Note extra diameter of Stud

Because the flange that holds the roller is a part of the stud itself, the STUD DIAMETER can be made up to 100% greater in relation to the size of the roller as shown.

CONTACT SMITH DISTRIBUTORS IN ALL MAJOR CITIES

Send for Bulletin 103—Lists Names and Addresses of Distributors

**THE SMITH BEARING CO. INC.**

STATION A, P. O. BOX 1119 TRENTON, N. J.

**In Today's Battle For Men's Minds... Our Greatest Weapon Is *Truth***

**Your Dollars Bring Truth and Hope Behind the Iron Curtain**

In a scant few years, the spirit of millions of East Europeans may be broken by the never-ending avalanche of Red lies, restrictions and distortions. A great hope remains for them and for the free world: the 29 powerful truth transmitters of Radio Free Europe. They broadcast the news as it really happens, destroy Red distortions, renew hope that freedom will one day return. But freedom is *not* free. Your dollars are needed to help operate Radio Free Europe, pay for its supplies, announcers, political analysts . . . keep its transmitters on the air. Send your truth dollars today to Crusade for Freedom, care of your local Postmaster.

***FREEDOM IS NOT FREE!***

*Your dollars are needed to keep RADIO FREE EUROPE on the air!*

SEND YOUR TRUTH DOLLARS TO

**CRUSADE FOR FREEDOM**

CARE OF LOCAL POSTMASTER

age ranges are available. Operates on 115 v ac. **Futurmill, Inc., 6360 Highland Rd., Pontiac, Mich.**

Circle 34, inside back cover

### Long delay intervals . . .

are possible with transistor-equipped time-delay relays with RC network. Permits intervals from 50 millisec to several hr. Line includes delayed pull-in, delayed drop-out and pulse types, all with a nominal accuracy of 10%. Package measures 1.5 cu in. min, weighs 3 oz. Voltage ranges are 14 to 32 v dc or 24 to 220 v ac. Units withstand temperatures of –67 to 257 F and meet military requirements for shock and vibration. Various mountings and connections are available. Applicable to warning systems, safety devices and triggering mechanisms. **Jordan Electronics, Div. Victoreen Instrument Co., 3025 W. Mission Rd., Alhambra, Calif.**

Circle 35, inside back cover

### Miniature dc motor . . .

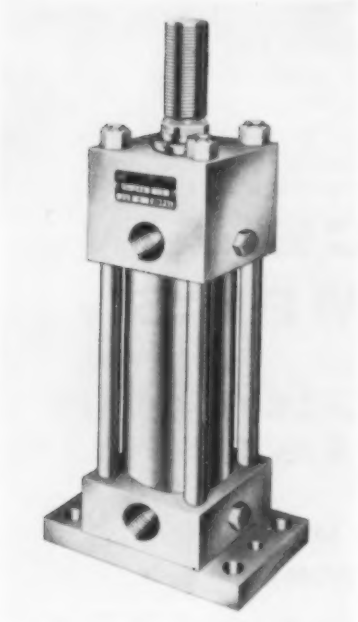
offers output speeds from 900 rpm to 2 rpd with gear train and from 960 to 3000 rpm without gear train, providing max torques of 30 and 0.6 in-oz, respectively. Current drain may be as low as 30 ma, depending on application. Voltage ratings are from 3 to 30 v dc. **Cramer Controls Corp., Centerbrook, Conn.**

Circle 36, inside back cover

### Heavy-duty cylinders . . .

are rated for 200 psi air and 1000 psi hydraulic. Offered in nine sizes, from 1½ to 8 in. bores, five mounting styles, a range of strokes. All models are available noncushioned, cushioned blind end, cushioned rod end or cushioned both ends. Barrels are honed seamless steel; and plates are steel and piston rods are heat-treated low carbon, low-alloy steel. Piston and cartridge-retained rod seals are designed for operation at temperatures from –20 to 150 F. Suited for application on machine tools, presses, transfer

(Continued on page 133)



machines, welding machinery, conveyors and dies. S-P Mfg. Corp., 30201 Aurora Rd., Solon, Ohio.

Circle 37, inside back cover

### Fuel controller . . .

for small air-cooled engines using LPG vapor or natural gas as fuel. The 3¾-in.-dia unit can be mounted directly on carburetor of most engines. An adjustable lock-off screw permits using inlet pressure of from 6 oz to 10 lb. Capacity is from 4 to 25 hp depending on inlet pressure used. Body is stamped from heavy-gage steel. Accessory kits have been designed for conversion of most popular engines. Garretson Equipment Co., Inc., Box 111, Mt. Pleasant, Iowa.

Circle 38, inside back cover

### Four-way solenoid valves . . .

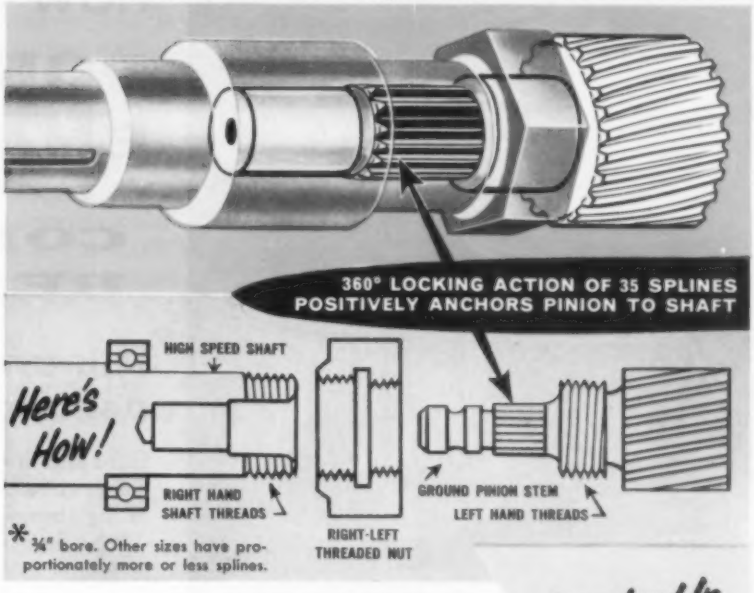
permit supply of full line pressures to cylinders from a remote position by solenoid action. Available in single or

(Continued on page 136)

FOOTE BROS. SPLINE DRIVE PINION

Takes 35 "Bites" *

to guarantee better power transmission


360° LOCKING ACTION OF 35 SPLINES POSITIVELY ANCHORS PINION TO SHAFT
HIGH SPEED SHAFT
Here's How!
RIGHT HAND SHAFT THREADS
RIGHT-LEFT THREADED NUT
GROUND PINION STEM
LEFT HAND THREADS

* ¾" bore. Other sizes have proportionately more or less splines.

SPLINE DRIVE PINION — Standard In GEARMOTORS AND LINE-O-POWER UNITS

advantages:

1. MORE LOCKING AREA

Self-broaching splines provide more internal locking surface than any other pinion . . . assure positive anchoring, even under reversing conditions.

2. GREATER STRENGTH

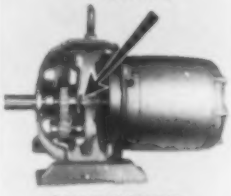
Gear and shank are machined from one piece. Solid construction and spline lock provide greater strength—no weakness due to projecting keyway.

3. PERMANENT, ACCURATE ALIGNMENT

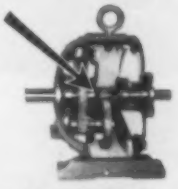
Self-centering action of ground pinion shank in the accurately bored high speed shaft assures accurate assembly and alignment for smoother performance.

4. DUTI-RATED GEARING

Foote Bros. Spline Drive Pinions have the famous Duti-Rated Gear—harder, tougher and more accurate, with greater load carrying capacity for their size than any other gearing.



GEARMOTOR



LINE-O-POWER UNIT

**SPLINE DRIVE PINIONS are another example of Foote Bros. leadership . . . another reason you can be sure you're buying the finest when you buy Foote Bros. Power Transmission Equipment.**

*this trademark stands for the finest industrial gearing made*

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FOOTE BROS.

*Better Power Transmission Through Better Gears*

FOOTE BROS. GEAR AND MACHINE CORPORATION
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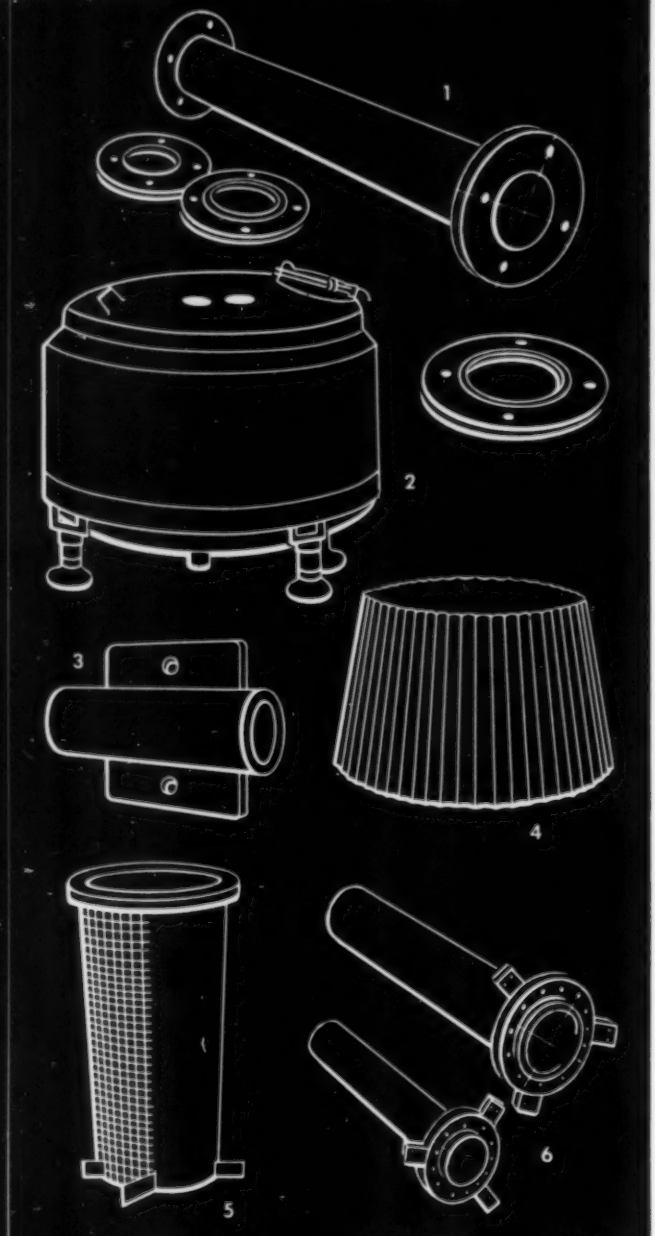



# HOW PORCELAIN ENAMEL'S CORROSION RESISTANCE improves product performance

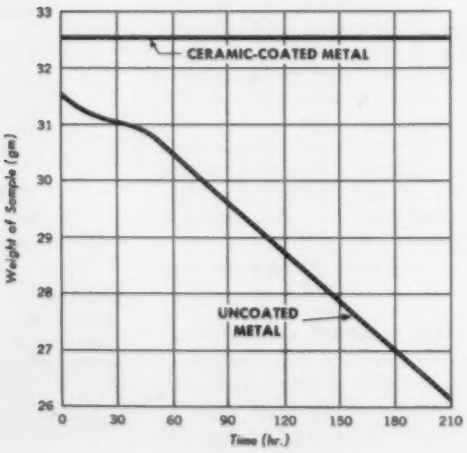
Hard and impervious, Porcelain Enamel is an inorganic, vitreous, siliceous coating permanently fused at high temperatures to metal.

Acid-resisting grades are immune to most acids, including sulfuric and nitric. Under the Porcelain Enamel Institute's acid resistance classification, Class AA acid-resisting Porcelain Enamel coating .004″ thick should withstand a boiling 5% sulfuric acid solution during many months of continuous attack.

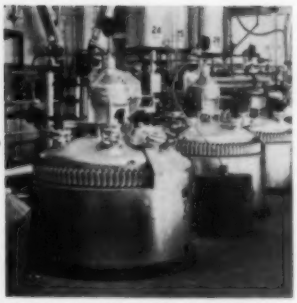
Various types of ground coats, one-fire enamels and cover coats may be selected to suit the application and use conditions.

All grades of Porcelain Enamel are resistant to organic solvents and alkaline solutions. Certain grades are unaffected by soil corrosion where acid, moisture and organic materials are encountered.

1. Pipe and Fittings
2. Processing and Storage Tank
3. Bearing for Pumps Handling Corrosive Liquids
4. Jet Engine Liner
5. Strainer Basket
6. Industrial Water Heater




Curve showing the effect of prolonged heating at 1700° F for coated and uncoated type 321 stainless steel.

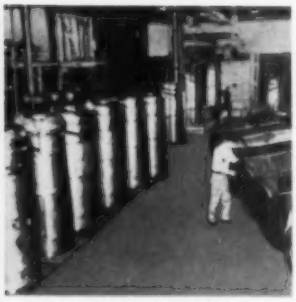


3000 gallon Porcelain Enameled reactors used for chemical processing.

## Porcelain Enamel Combats *Chemical Attack*

In many chemical processing applications Porcelain Enamel has extended equipment life by as much as 500%—in all cases without danger of rust contamination of the product being processed. In smokestacks where combustion by-products have a corrosive effect on metal, the use of Porcelain Enamel has resulted in from three to five times longer service.

Porcelain Enamel, which has a hard, glass-like surface, resists corrosive attack from most chemicals, including those found in food, chemical, pulp, paper, dye and petroleum processing.



Ceramic-coated afterburners for jet engines.

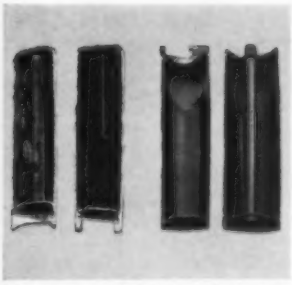
## Porcelain Enamel Combats *High Heat Combined with Chemical Attack*

High-temperature ceramic coatings, which are Porcelain Enamels fortified with refractory materials, resist corrosion at temperatures up to 2,000°F. Combustion chambers and exhaust systems of jet and rocket engines and heat exchangers of domestic and commercial furnaces are representative applications. Durability of stainless steels and high temperature alloys is extended substantially by means of a thin ceramic film which insulates the material from surface atmospheres.

In this type of application ceramic coatings do three things: (1) extend length of service of high-temperature alloys, (2) extend temperature service range of others, (3) permit substitution of low-alloy steels which are less rich in strategic elements.

## Porcelain Enamel Combats *Moisture*

Millions of water heaters are "glass lined" to handle severely aggressive waters under pressure. Porcelain Enamel also combats alkaline attack of sea water in marine engines where the hot exhaust mufflers and pipes constantly are exposed to cold sea water. Porcelain Enamel's excellent thermal shock resistance is an added bonus value.



Comparison of Porcelain Enameled, right, and ordinary water heater after service.

## Porcelain Enamel Combats *Atmospheric Corrosion*

In salt air and in industrial atmospheres where gases and smoke are factors, Porcelain Enamel has demonstrated extraordinary resistance to deterioration. Despite combined attacks of heat, cold, rain, snow, ice and sunlight many outdoor signs made of Porcelain Enamel more than 50 years ago still retain their gloss and original colors.

Architectural Porcelain Enamel resists the elements and corrosive atmospheres in seacoast and industrial areas.

*Designers use* **PORCELAIN ENAMEL** *for these additional properties*

*Thermal Properties*

*Hardness*

*Electrical Properties*

*Color and Texture*

**PORCELAIN ENAMEL INSTITUTE**
Associations Building
1145 Nineteenth Street, N.W.
Washington 6, D.C.

Please send the following:

- ☐ Porcelain Enamel Design Manual
- ☐ List of companies engaged in Industrial and General Porcelain Enameling
- ☐ Design information about possible application of Porcelain Enamel to _____ (type of product)

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____

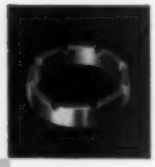
(Please Print)

*a new expanded field of*

# BEARING DESIGN and APPLICATION

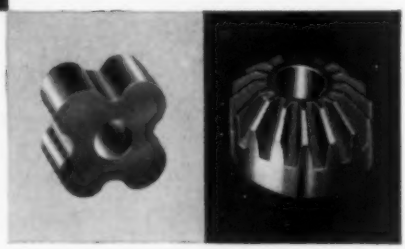
The inauguration of Bunting's new facility for engineering and manufacturing bearings and parts of Sintered Powdered Metals opens a wide new area of opportunity to all mechanical industry.

Sintered Powdered Metal Bearings and parts offer real economies in design. Bunting Engineering and manufacturing skill and traditional technical responsibility assure your most advantageous use of this material.



A competent group of Bunting Sales Engineers in the field and a soundly established Product Engineering Department put at your command, comprehensive data and facts based on wide experience in the designing and use of both Cast Bronze and Sintered Powdered Metal Bearings and parts.

● *Write for catalogs and your copy of the new 24 page Bunting Engineering handbook of Sintered Powdered products and their composition, manufacture and application.*



**Bunting®**

**BUSHINGS, BEARINGS, BARS AND SPECIAL PARTS OF CAST BRONZE AND POWDERED METAL**

**The Bunting Brass and Bronze Company • Toledo 1, Ohio • Branches in Principal Cities**

double solenoid models, with or without sub-base, for 110, 220 or 440 v ac in ¼, ⅜, ½, and ¾ in. NPT sizes. Suitable for continuous or intermittent duty. Incorporates poppet-valve design. Oil-resistant rubber is used in the washers for a leakproof seal. Springs are stainless steel. **A. Schrader's Son, Div. Scovill Mfg. Co., Inc., 470 Vanderbilt Ave., Brooklyn 38, N. Y.**

Circle 39, inside back cover

## Turntable test stand . . .

includes servo drive, dials and a two-speed rotation transmitting system. Mounting may be vertical or trunioned for tilting. For use where a sturdy, rigid servo turntable is required and the limited tests do not justify cost of a complete turntable-testing assembly. **Sterling Precision Corp., Instrument Div., 17 Matinecock Ave., Port Washington, N. Y.**

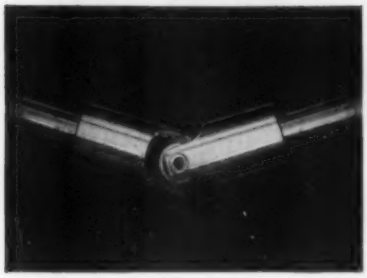
Circle 40, inside back cover

## Preprinted electronic symbols . . .

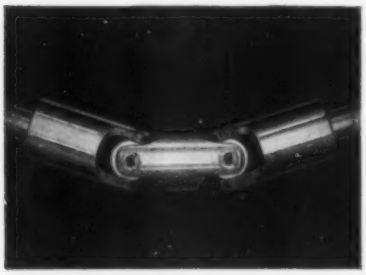
on a clear acetate sheet are affixed by pressure-applied dry adhesive to drawings. Individual symbols are removed with a pointed stylus. A drawing made in part or all with this material can be used immediately for reproduction. Drawings are permanent and symbols will not come loose or pop off. Background is said not to yellow with age or lose transparency. Surface is a matte finish that will take pencil, ink and erasure without damage. Each 6 x 9-in. sheet contains a symbol duplicated an average of 48 times, depending on size. Available are 165 different sheets covering 635 components. The

(Continued on page 137)

# How Curtis helped a design engineer "BEAT THE HEAT"



This single universal joint in a ribbon-stripping machine was operated at a 34° angle. The joint heated up, wear was excessive. (Curtis Joints have been tested at angles up to 37°, but we do not ordinarily recommend angles greater than 30°.)



Curtis engineers recommended a *double* Curtis joint, which reduced the angle to 17° per joint. Result: no overheating, improved efficiency, longer life.

You can depend on Curtis engineering in any problem of angular power transmission. And you can depend on

**CURTIS UNIVERSAL JOINTS**

because our catalog torque and load ratings are substantiated by constant tests under production conditions.

**14 SIZES ALWAYS IN STOCK —**
3/8" to 4" O.D. (6" joints on special order)

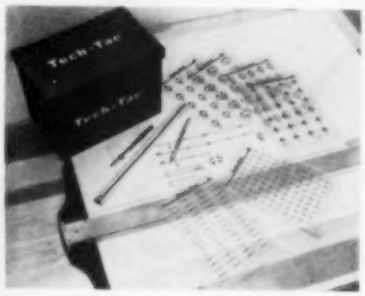
***Not sold through distributors. Write direct for free engineering data and price list.***

TRADE MARK **CURTIS**

**UNIVERSAL JOINT CO., INC.**
**11 Binnie Avenue, Springfield, Mass.**
*As near to you as your telephone*

**EXCLUSIVELY A MANUFACTURER OF UNIVERSAL JOINTS SINCE 1919**



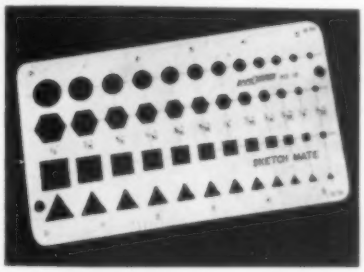
entire system, complete with desk top file guide and index, stylus and one each of the 165 sheets, sells for about $150. Replacements are 85¢ per sheet. **Tech-Tac, Inc., 727 W. 7th St., Los Angeles 17.**

Circle 41, inside back cover

## Tracing film . . .

has an excellent surface for pencil and has a 0.002 in. Mylar base. The material is said to be non-yellowing and waterproof. A high degree of transparency provides fast reprinting speeds. Accepts up to 6H pencil, may be typed on and accepts pre-printed title blocks or other information. Available in 20-yd x 36-in. rolls and in standard cut-sheet sizes. **Ozalid Div., General Aniline and Film Corp., 15 Corliss Lane, Johnson City, N. Y.**

Circle 42, inside back cover



## Layout template . . .

has circles, hexagons, squares and triangles grouped in sizes from 3/32 to 1/2 in. in increments of 32nds to 3/8 in. and 16ths thereafter. Has two 5-in. scales, one graduated in 10ths and the other in 16ths. Over-all size is 5 1/2 x 3 1/4 in. **Rapidesign, Inc., P. O. Box 429, Burbank, Calif.**

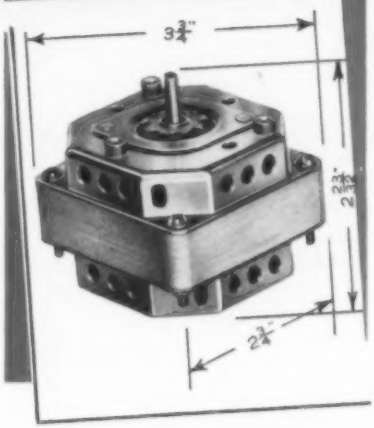
Circle 43, inside back cover

## 36-channel oscillograph . . .

makes records up to 200 ft long with a wide selection of record speeds. Records at frequencies from dc to 5000 cps at sensitivities said to be identical to photographic-type oscillographs. Permits recording directly on paper, without processing. Records are immediately visible

(Continued on page 139)


**SMALL! COMPACT!**
**with outstanding power-to-weight ratio**

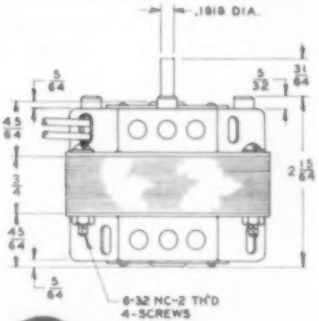



YOU CAN ALWAYS

***RELY on GI***

**Fractional H. P. Motors**
1/40 H. P. to 1/1100 H. P.

Exceptionally smooth and silent, the Model E, shown here, is widely used in high quality tape recorders, record changers, and complete motor assemblies in hi-fi units. It is also readily adaptable to many other applications, such as business machines, vending machines, advertising displays, juke boxes, etc. Mechanically and electrically symmetrical for minimum stray field radiation.

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**THE GENERAL INDUSTRIES CO.**

DEPARTMENT GK • ELYRIA, OHIO

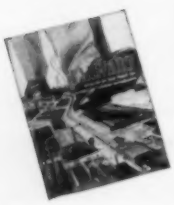
DID YOU SAY RUBBER PARTS WITH **HIGH THERMAL STABILITY?**

that's right!
**STALWART SILICONE**
rubber parts
resist
temperatures
from -160°F. to +600°F.

. . . and here's more good news for design engineers! Stalwart can replace heavy, awkward designs with precision-made silicone rubber parts that are lighter and smaller.

Stalwart engineers will work closely with you to produce Silicone parts to meet your most exacting specifications. For special applications, Stalwart can supply fabric-inserted shapes. Silicone shapes also can be covered with Nylon, Dacron, Orlon and fiberglass. Parts can be supplied in realistically-priced production or job-lot quantities.

Discover for yourself why more and more design engineers are specifying Stalwart Silicone rubber parts. Write today for Bulletin 56-SR-3.

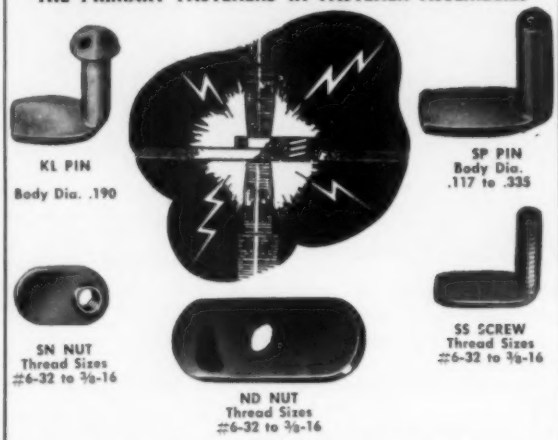


7846-SR

**STALWART RUBBER COMPANY**
Main Office:
166 Northfield Road, Bedford, Ohio
Manufacturing plants in Jasper, Georgia and Bedford, Ohio

**OHIO SPOT WELDING FASTENERS**

**THE PRIMARY FASTENERS IN FASTENER ASSEMBLIES**




If you do spotwelding you can attach OHIO Spotweld Fasteners at the same time for faster, trouble-free assembly.

**OVER 50 YEARS OF BETTER FASTENING**

Samples and information available upon request.

**THE OHIO NUT & BOLT CO.**
**41 First Avenue • Berea, Ohio**

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**HIGH FREQUENCY**
*Induction* **HEATING**

**HARDENING**
**SOLDERING**
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**LEPEL Electronic Tube**
**GENERATORS—1 KW; 2½ KW, 5 KW; 10 KW; 20 KW; 30 KW; 50 KW; 75 KW; 100 KW.**
**LEPEL Spark Gap Converters**
**2 KW; 4 KW; 7½ KW; 15 KW; 30 KW.**

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All Lepel equipment is certified to comply with the requirements of the Federal Communications Commission.

**LEPEL HIGH FREQUENCY LABORATORIES, INC.**
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and usable. Especially adaptable for monitoring and recording reference and error signals, temperature and pressures in nuclear experiments and evaluation of design in tests of missiles and rockets. **Heiland Div., Minneapolis-Honeywell Regulator Co., 5200 E. Evans Ave., Denver 22.**

Circle 44, inside back cover

### Thrust washer kit . . .

contains 18 sizes of washers, made of molybdenum disulphide filled nylon. Transparent plastic box identifies each type and size. Washers are said to have better dimensional stability, greater rigidity and higher heat-distortion temperature than unfilled nylon 101, plus lower surface friction and better wear resistance in many applications. Kit is $15. Line of 39 sizes of thrust washers, which this kit represents, includes $\frac{3}{8}$ to 1 in.-OD, thicknesses of $\frac{1}{64}$, $\frac{1}{32}$ and $\frac{1}{16}$ in. **Polymer Corp. of Penna., 2140 Fairmont Ave., Reading, Penna.**

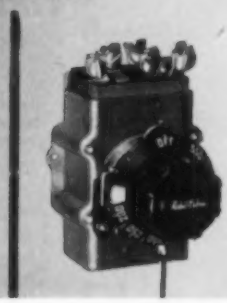
Circle 45, inside back cover

### Shorter pin plugs . . .

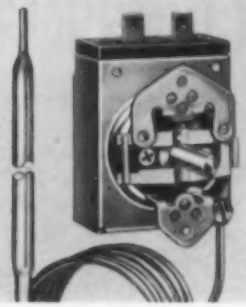
are recommended as a substitute for standard sizes when space is limited. Shorter plugs seal drilled holes bone dry under pressures to 10,000 psi or higher, depending on size and material. Available in aluminum and stainless steel. **Lee Co., Wesley Ave., Westbrook, Conn.**

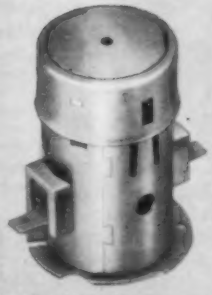
Circle 46, inside back cover


**3-Phase Thermostat**—available in various temperature ranges and dial markings. For use with 3-phase circuits on heavy duty electric ranges, sealing machines, etc. In operation, 2 phases keep cycling while the third phase is "on" during the entire operation. In "off" position all three phases are broken.

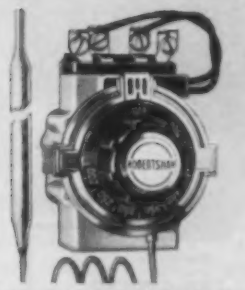


**Domestic Appliance Controls** for ranges, clothes dryers, air conditioners, room heaters, etc. Low in cost, compact and dependable, with quick response to extremely close temperature differentials. Silver contacts and stainless steel bellows for sustained accuracy.





**Combination Fixed-Temperature Control and Switch** for restaurant coffee warmers, egg washers, heaters for livestock water tanks and many other applications where a low cost control for maintaining a fixed temperature is required. Eliminates the problem of too much or too little heat.



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operates at 140° F. — without watercooling!

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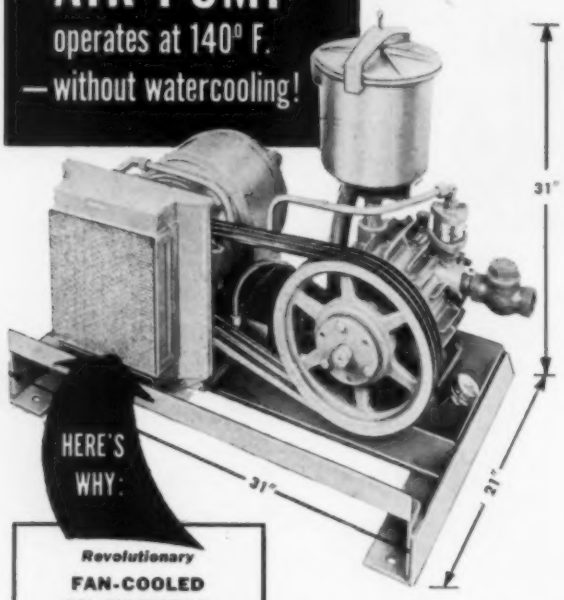


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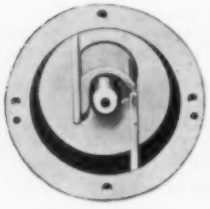

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Precision-honed cylinder walls are made of durable cast iron; wings are made of wear-resistant steel (not composition). Automatic wing adjuster assures constant wing-to-wall contact, prevents sticking or binding. Pump takes up its own wear to provide maximum vacuum for years.

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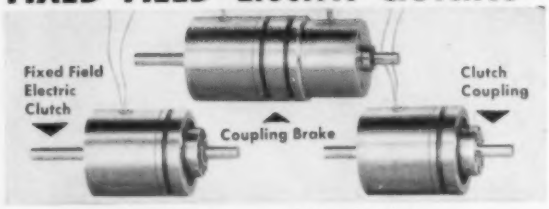


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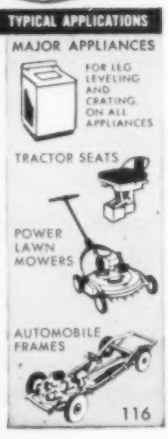


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# CATALOGS and BULLETINS

*To obtain copies of literature described below, circle corresponding number on postcard inside back cover.*

**HYDRAULIC SYSTEMS**–Bulletin B-4, 44 pp. A revised introduction to the principles of hydraulic systems, with explanations of the most important types of valves, pumps, motors, torque converters and accessories. An explanation of oil characteristics is followed by sections on oil selection and trouble-shooting. Sun Oil Co., Philadelphia 3.

Circle 47, inside back cover

**PRESSURE GAGES**–Catalog G-58, 48 pp. Engineering data and selection tables for various applications. Describes line of air, gas, vapor and liquid gages with ranges from 15 psi or 30-in. of vacuum to 20,000 psi. Kunkle Valve Co., 120 S. Clinton, Fort Wayne, Ind.

Circle 48, inside back cover

**TENITE POLYETHYLENE RESINS**–Brochure, 36 pp. Separate sections on each of six basic uses for polyethylene–molding, pipe, film, coatings, blowing and wire and cable covering. Outlines advantages and gives specifications. Profusely illustrated with applications in housewares, toys, appliances, packaging, paper coating, insulation and pipe. Eastman Chemical Products, Inc., Kingsport, Tenn.

Circle 49, inside back cover

**EXTRUDED SHAPES**–Booklet, 44 pp. Reviews design and cost advantages of extruded shapes and cites 16 case histories. Data on extrusion process, group drawings of extrudable shapes in profile, tables of comparative properties of copper-base alloys, selection data, and information on high-conductivity copper bus channels and angles are included. One section is devoted to quality control. Revere Copper and Brass, Inc., 230 Park Ave., New York City.

Circle 50, inside back cover

**CONTROLLED SPEED SYSTEMS**–Brochure, 8 pp. Descriptions and illustrations of typical applications developed by company. U. S. Electric Motors, Inc., Box 2058 Terminal Annex, Los Angeles 54.

Circle 51, inside back cover

**SPECIALITY STEELS**–Brochure, 12 pp. Various grades of steels, together with castings, welding electrodes, magnets, springs and tool bits, are discussed in relation to heavy equipment. Recommended technical manuals and aids are described. Crucible Steel Co. of America, Oliver Bldg., Pittsburgh 22.

Circle 52, inside back cover

**AIRCRAFT STEELS**–Booklet, 72 pp. 1958 revised edition contains condensed information on Army, Navy and government aeronautical specs. Booklet lists aircraft-quality alloy and stainless steels available for immediate shipment, explains meaning of aircraft-quality and includes data on a plan of quality control. Joseph T. Ryerson & Son, Inc., Box 8000-A, Chicago 80.

Circle 53, inside back cover

**FREE LUBRICATION KIT**–Contains dry lubricant, applicator and metal part, plus instructions for testing. Lubricant is used where extreme temperatures or extreme pressures are a factor. EverLube Corp., 6940 Farmdale Ave., N. Hollywood, Calif.

Circle 54, inside back cover

**SELF-BONDED SILICON CARBIDE**–Pamphlet, 4 pp. Tabulates properties, mechanical strength, thermal expansion coefficients, comparative thermal conductivity, oxidation resistance in air, resistance to corrosive liquids and stability in steam. Also electrical properties, fabrication and possible uses. Carborundum Co., P. O. Box 337, Niagara Falls, N. Y.

Circle 55, inside back cover

**HYDRAULIC AND AIR CYLINDERS**–Bulletins H-101 and A-101, 8 pp each. Tabulates developed forces and gives dimensional data. With schematics and dimensional drawings. Includes accessory information. Lindberg Air & Hydraulic Div., Teer, Wickwire & Co., 1839 Wildwood Ave., Jackson, Mich.

Circle 56, inside back cover

**SOLENOID VALVES**–Bulletin, 4 pp. Information on direct-lift valve series. Includes operation data, specs, performance data and applications. With schematics and dimensional drawings. Atkomatic Valve Co., Inc., 545 W. Abbott St., Indianapolis, Ind.

Circle 57, inside back cover

**BORON NITRIDE**–Bulletin, 4 pp. Properties, advantages and uses of this impermeable ceramic material. Contains typical analyses, tabulations of oxidation

(Continued on page 142)


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Catalogs and Bulletins . . . . . continued

in air, and other characteristics. Carborundum Co., P. O. Box 337, Niagara Falls, N. Y.

Circle 58, inside back cover

**CUP PACKINGS**—Folder, 4 pp. Describes fabricated-rubber hydraulic packings and gives applications, a table of max clearances between packing follower plates and cylinder walls, and a listing of all standard sizes. E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33.

Circle 59, inside back cover

**RETRACTILE ELECTRIC CORD** — Catalog 582, 16 pp. Revised booklet includes simplified tabular material giving types, sizes and color available. Koiled Kords, Inc., Box K, New Haven 14, Conn.

Circle 60, inside back cover

**QUICK-CONNECT COUPLINGS** — Catalog, 26 pp. Describes couplings for guided missile, aircraft use and other exceptional applications. Gives size, weight, coupling material, basic design information and original application for each coupling. Snap-Tite, Inc., Union City, Penna.

Circle 61, inside back cover

**DIGITAL-STRAIN-GAGE INDICATOR**—Brochure, 4 pp. Includes schematic diagram to show that shunting effect across transducer bridge is always the same regardless of position of follow-up potentiometer. Suggests applications. Text discusses how this instrument, when supplied with an analog-to-digital shaft converter, becomes the heart of a multichannel automatic digital recording system. Datran Electronics, 1836 Rosecrans Ave., Manhattan Beach, Calif.

Circle 62, inside back cover

**ROLLED TUBE SHEETS**—Brochure, 8 pp. How process permits a designer to create any pattern of tubing within a single homogeneous sheet of metal. Available sheet sizes, tubing dimensions, pressure ratings included. Western Brass Mills Div., Olin Mathieson Chemical Corp., East Alton, Ill.

Circle 63, inside back cover

**SOLID FILM LUBRICANTS**—Catalog LB-6-1157, 16 pp. Describes eight different solid-film lubricants and their applications. Specs and performance data are included. Electrofilm, Inc., P.O. Box 106, North Hollywood, Calif.

Circle 64, inside back cover

**PLANETARY-GEAR REDUCERS** — Catalog, 8 pp. Discusses advantages of gear reducer and describes seven basic reducer models covering all horsepower requirements. Each model has 30 different

(Continued on page 145)


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**Stroke and Revolution Counters for the *Toughest* Jobs**

- **200 Million Count Life**
- Rugged, oversize shaft and bearings
- Shakeproof—only one screw in counter assembly.
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Thousands used in Automobile and Aircraft factories; in stamping, metal working, die casting and plastic molding plants; in foundries, printing plants and factories.

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- 7 watts power consumption—operable in plate circuit of electronic tubes.
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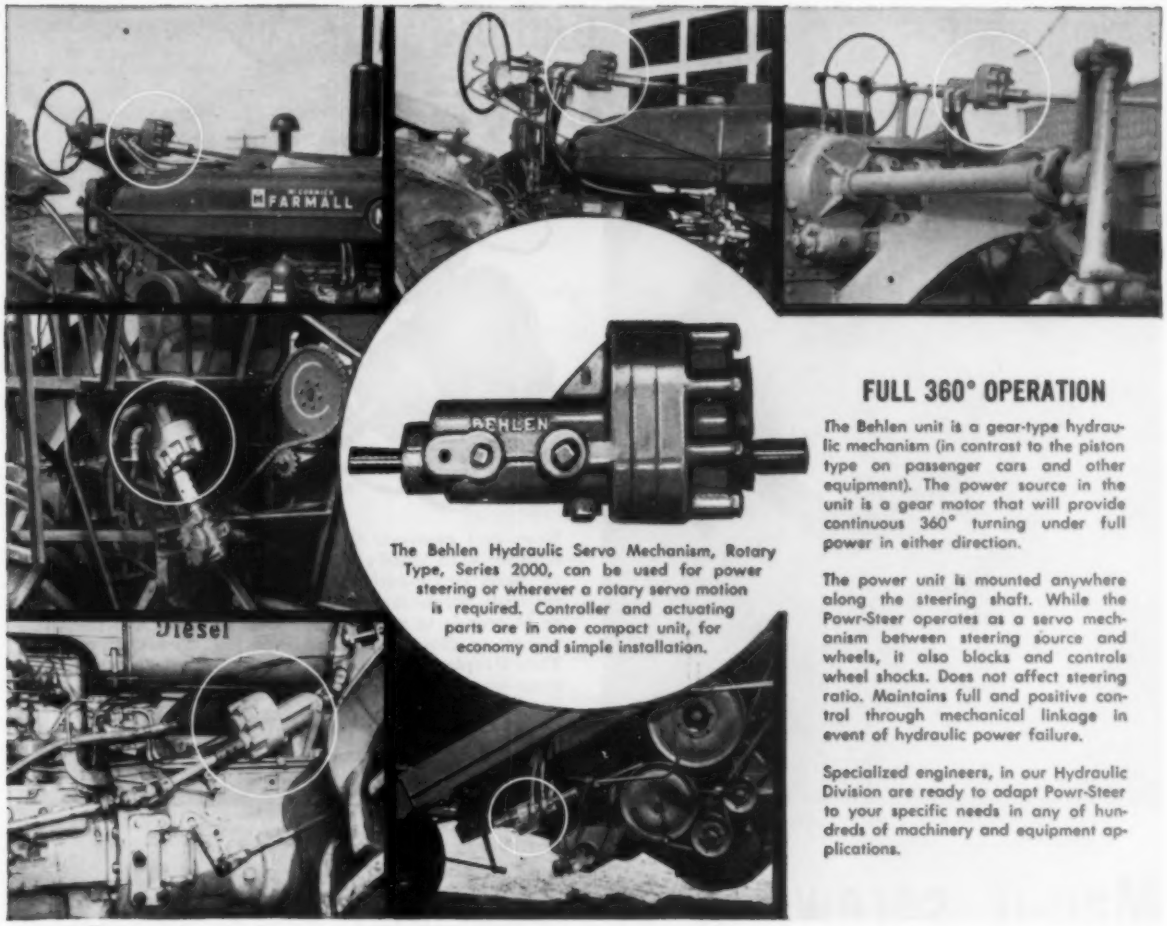


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**We want you** to see how easily the mechanism can be applied to your products as original equipment, and how it can add a big plus to the sales appeal. Get in touch with us now.

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Actual overall length horizontal models: 3½", 5", 6".

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**Now—put pressure where it's wanted instantly and cheaply, with Mead's powerful new midget air cylinders (1" bore, single-acting, spring return—horizontal and vertical). Stroke is adjustable. Cut costs—use 'em singly or in groups to move, hold, press or eject small work pieces; to close and open large jigs, forms, fixtures. They'll replace human fingers and mechanical clamps in countless routine jobs.**

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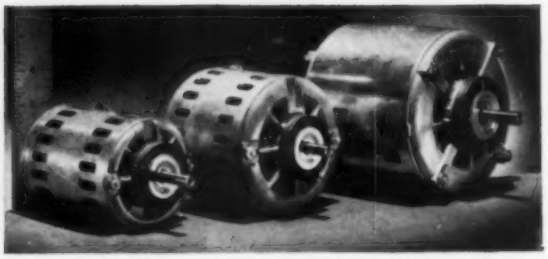

- 3" dia.: 15 mhp thru 1/12 hp (2-pole); thru 1/20 hp (4-pole)
- 3 7/8" dia.: 15 mhp thru 1/3 hp (2-pole); thru 1/8 hp (4-pole); thru 1/20 hp (6-pole)*
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  - **SMALL, LIGHT:** enhances your product designs.
  - **SAVE:** space, weight, freight.
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*3-phase ratings also available.

**FREE BULLETIN!** Write for descriptive bulletins to Section 633-4, Schenectady, N. Y.

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ratios. With dimensional drawings and specs for each. Crichton Co., 520 Vine St., Johnstown, Penna.

Circle 65, inside back cover

**COMMERCIALLY PURE TITANIUM**—Brochure, 8 pp. Describes properties and corrosion-resistance of pure titanium. Fabrication techniques are outlined. Mallory-Sharon Metals Corp., Niles, Ohio.

Circle 66, inside back cover

**UNIVERSAL JOINT**—Bulletin, 4 pp. Descriptions of standard and custom-built joints, split block and solid block in sizes ranging from $\frac{3}{8}$ to 4 in. Specs are tabulated. Borgeson Mfg. Co., Inc., 38 Monroe St., Torrington, Conn.

Circle 67, inside back cover

**TEMPERATURE CONTROLS**—Catalog MC-156A, 4 pp. Nine different types of controls are described. Temperature and current ratings are given for all models. Fenwal, Inc., Pleasant St., Ashland, Mass.

Circle 68, inside back cover

**INDUSTRIAL RETAINING RINGS**—Catalog, 16 pp. Engineering specs on entire line are supplemented by dimensional drawings. Industrial Retaining Ring Co., Dept. PB-31, 57 Cordier St., Irvington 11, N. J.

Circle 69, inside back cover

**CONTROL DEVICES**—Catalog GEC 1260C, 88 pp. Covers line of control devices with descriptions, features, wiring diagrams, dimensions, application data and prices. Indexed. General Electric Co., Schenectady 5, N. Y.

Circle 70, inside back cover

**ROLLER CHAIN AND SPROCKETS**—Catalog ARC-55A, 52 pp. Construction details, specs, selection and design data, and characteristics of roller chain and sprockets. Includes list prices. Atlas Chain & Mfg. Co., West Fittston, Penna.

Circle 71, inside back cover

**Reprints of two articles . . .**

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**Fan Selection**
Circle No. E21

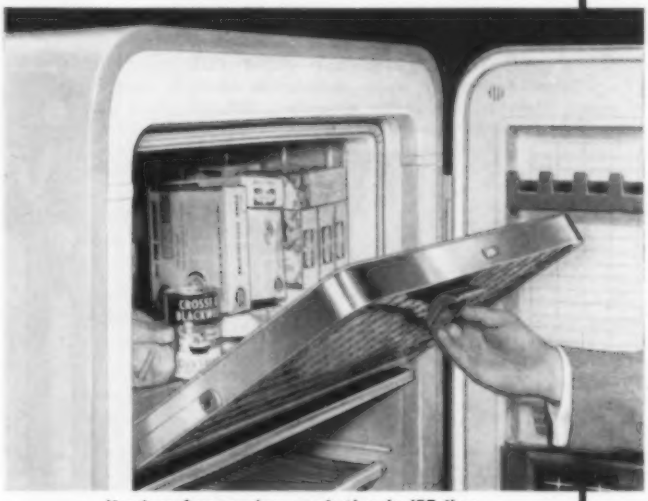
For free reprints from earlier issues see complete listing on page 155 in this issue.


# Rubatex Gaskets meet special Kelvinator requirements

Rubatex closed cellular structure gives Kelvinator engineers just what they want . . .

"a non-moisture absorbing material . . . one that has sufficient resiliency to permit a firm, quiet door closure . . . plus a gasket that can be depended upon for a tight effective seal against loss of cold and entry of warm, humid air."

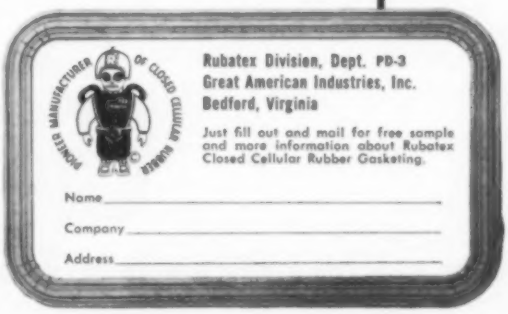
In addition to these important features, Kelvinator engineers also use Rubatex because it is convenient to work with and easy to apply in the assembly process.



**Used as freezer door gasketing in '57 line — continued in Kelvinator '58 line**

The principal application of RUBATEX in Kelvinator's combination refrigerator-freezer is a continuous gasket completely surrounding the freezer opening, on top, bottom and both sides.

This is a Closed Cellular Rubatex stock (No. G-251-C) especially developed in a light gray to give a fresh look and to blend beautifully with the metal door.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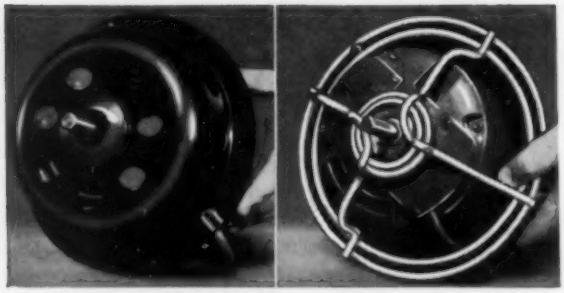
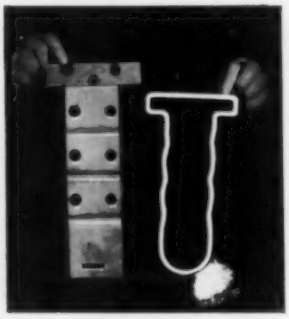


MOTOR MOUNT for Air Conditioner—COST CUT 50%. Original deep-drawn motor mount was costly and noisy. Titchener Wire design cut weight, reduced noise and cut time and material costs.



COST of Door Anchor CUT 70%—used to anchor metal door frames to masonry construction. Titchener redesign is lighter, stronger and the natural resilience of wire absorbs shock.

Learn how you can cut costs and improve your product with Wire/Strip assemblies. Send a drawing, photograph or sample of your product; better yet, visit our plant . . . there's no obligation.

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- ☐ "How Wire Construction Reduces Costs"
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## VARIABLE SPEED DRIVES

- Complete
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# DESIGN ABSTRACTS

## Operational Integrity in Aircraft Systems

Complexity of new aeronautical equipment has increased so sharply that new approaches to their design and revised engineering procedures are required. How analyses of the effect on failure, methods of predetermining reliability are used in design is described, together with organizational considerations on report systems.

*Abstracted from "The Quest for Operational Integrity of New Aircraft Systems," by J. deS. Coutinho, Grumman Aircraft Engineering, Inc., ASME paper 58-AV-3, 29 W. 39th St., New York 18.*

## Hydraulic Systems at Elevated Temperatures

**"Mechanical Factors in the Design of Hydraulic Equipment for Elevated Temperatures," by A. Mars, M. M. Lazar; Vickers, Inc., (ASME paper 58-AV-11)** appraises available materials for 400 to 900-F operating-temperature range and describes some service experiences. Creep strains, dynamic and alternating stresses and wear are among the three factors to be considered. Hot-worked die steels have been successfully applied to highly stressed parts and wear parts. For even more severe applications high-speed steels are suggested, and where corrosive conditions prevail, Martine-Fitic are work-hardening stainless steels. The cast irons usually give structural stability to about 800 F. Nonferrous alloys exhibit increased creep rates, but forthcoming materials may be able to overcome this.

**"Monitoring of Hydraulic Fluids During High Temperature Test," by R. L. Leslie, Vickers, Inc., (ASME paper 58-AV-8)** emphasizes the importance of a regular check-up system on changes occurring at 400 to 550 F. Methods of testing viscosity, flash point, suspending solids, acid number and other properties are discussed. Service effects on many of the synthetic hydraulic fluids are described; how they influence equipment operation is evaluated.

**"Designing and Testing for High Temperature Hydraulics," by F. L. Moncher and L. D. Taylor; Vickers, Inc. (ASME paper 58-AV-6)** describes test procedures and facilities for evaluating qualifying hydraulic systems for use at temperatures above 400 F. Such testing is complicated, difficult to control and expensive—at least to date. Certain technological breakthroughs are minimizing difficulties.

## How Heat Treatment Affects Corrosion Resistance of Stainless

The lower-cost stainless chromium steels combine resistance to corrosion with high strength. Although less corrosion resistant than the austenitic stainless steels, they are adequate for many mildly corrosive media like alkalis and organic acids. But optimum corrosion resistance depends on heat treatment and composition. Several pointers are given for best properties from these steels.

- Avoid carbide formation. Carbides tie up free chromium that imparts passivity.
- Raise solution temperature to dissolve complex chromium-iron-carbides. These dissolve more slowly than the ordinary iron-carbides.
- Do not overheat. While corrosion resistance is not lowered by overheating, this coarsens grains and lowers toughness.
- Avoid tempering range from 870 to 1125 F.
- Keep free chromium above 11%. Percent chromium minus ten times carbon content should be at least 11%. However, free chromium much above 14%, while it gives still more corrosion resistance, lowers maximum hardness and consequently strength.

*Abstracted from "Influence of Heat Treatment on Corrosion Resistance of Stainless Chrome Steels," by Dr. Ing. R. Pospisil, Czechoslovak Heavy Industry, Vol 10, '57, 13, Prague 1, Czechoslovakia.*

## What Happened at the Design Show

Editors of *Product Engineering* attended every technical session, noting the comment of panel members, questions from the floor and discussion; visited every exhibit looking for new design ideas, new materials and components, new production methods and services. An 8-page report, written as the Show closed on Thursday last week, is included in this issue starting on page 41.


TIPS on using GIBSILOYS

GIBSON CONTACTS

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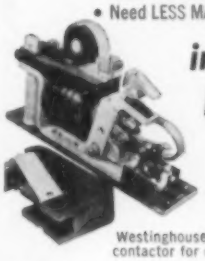
- Are SELF-CLEANING
- Need LESS MAINTENANCE



in Diesel Locomotive Starting Contactor

Westinghouse special engine starting contactor for diesel electric locomotive

Westinghouse electrical controls for diesel locomotives require electrical contacts capable of handling heavy currents without sticking. In addition contacts must have high electrical conductivity and great mechanical strength. Copper-graphite Gibsiloy UC-7 contacts, recently introduced for this service, are found by Westinghouse engineers to meet the needs of this contactor. Graphite reduces welding tendencies of the contacts and imparts self-cleaning properties. This reduces normal maintenance costs on the contactor.

The copper-graphite Gibson material is less expensive than silver-graphite, has good mechanical wearing properties and maintains good electrical and thermal conductivity. For these reasons Gibsiloy UC-7 has performed exceptionally well in this Westinghouse locomotive contactor.

For complete information on all Gibsiloy contacts made of silver, copper, nickel, tungsten, palladium and other materials, write to Gibson. The same experience in design and manufacture of Gibsiloy UC-7 approved by Westinghouse for locomotive controls is available to solve *your* electrical contact problems.

*Gibsiloy UC-7 faced contact used in Westinghouse engine starting contactor for diesel electric locomotive

See our catalog in Sweet's Product Design File or write for Gibson Catalog C-520.

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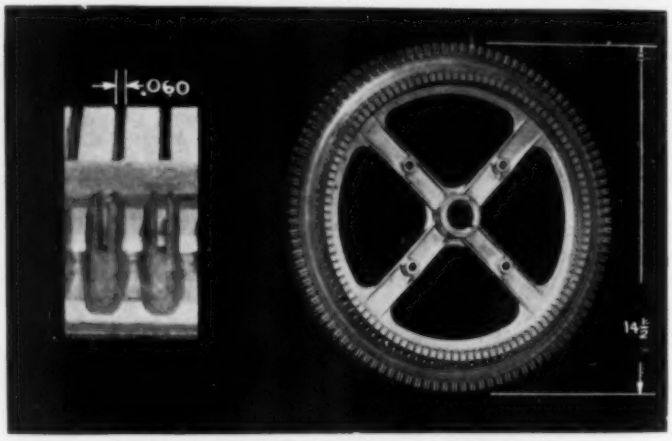


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# NEW BOOKS

## Thermal Properties of Plastic Laminates, Cores, Sandwich Panels

F. R. O'Brien and S. Oglesby Jr. *Southern Research Institute. PB 121191. Paperbound, Part 2 of WADC Technical Report 54-306. Paperbound, 8½x10½, 67 pp. $2.*

This report describes measurement of the thermal properties of a selected group of plastic laminates, cores, and sandwich panels. Thermal conductivity, specific heat, and thermal expansion were determined for four glass-fabric laminates with the same reinforcing fabric but with different resins, four foamed plastic cores, one foam sandwich panel, and one honeycomb panel.

## Properties and Testing of Plastic Materials

A. E. Lever and J. Rhys, *National College of Rubber Technology, England. Published by Chemical Publishing Co., 212 Fifth Ave., New York. 6¼x9¼, 197 pp. $4.75.*

This book summarizes basic properties of plastic materials, as well as the many tests that have been devised for them. No attempt is made to evaluate the various methods, nor to present any useful amount of data from them. However, as a reference work this volume is invaluable because of its extended bibliography, which is closely integrated with the text. If you want to know where to go for more information, or if you want to find out what some unfamiliar test is—this is a handy book to own.

## Engineering Materials Handbook

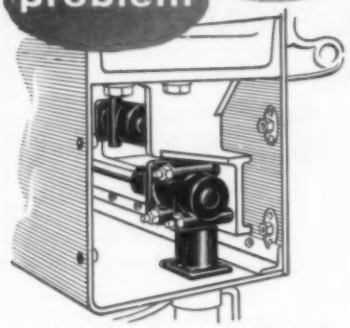
*Edited by* Charles L. Mantell. *Published by McGraw-Hill Publishing Co., Inc., 330 W. 42nd St., New York 36. 6¼x9¼, 1936 pp. 648 illustrations. $21.50.*

In 43 separate sections, carefully organized by a staff of specialists, this up-to-date handbook covers metals, organic and inorganic materials, and causes and prevention of failure in

(Continued on page 149)

ANGLgear®

solves space and weight problem



Drawing based on photo shows Model R-320 ANGLgears used on Goodyear missile-handling equipment. Compact, high-capacity ANGLgears solved problem of 90° drive in restricted space.

In designing its missile-handling equipment, Goodyear Aircraft Corp. required several 90° power takeoffs for the Nose and Booster handling pack. Combing the field of available right-angle gears, Goodyear engineers determined that ANGLgear was best capable of performing the necessary functions and meeting space and weight requirements.

Perhaps you have a similar design problem involving right-angle power transmission in a restricted space. If so, ANGLgear offers you high capacity, compactness and light weight, plus the flexibility of 4-way mounting. Furthermore, ANGLgear is completely enclosed, permanently lubricated; requires virtually no maintenance.

ANGLgears are available from stock in ⅓ to 5 hp ratings, with 2 or 3-way shafting, and 1:1 or 2:1 gearing. See our literature in Sweet's Product Design File or contact your local distributor.

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materials. Emphasis is on fabricated forms of materials, their physical and mechanical properties, adaptations, advantages, limitations, competition with each other, and protection against deterioration.

This comprehensive and authoritative handbook is a welcome addition to the engineer's reference shelf. It will help solve the unusual as well as the routine problem in material selection. Special sections deal with radiation effects on materials, the new exotic metals, liquid metals, and sources of information on engineering materials.

However, the more common materials are not neglected for the unusual. The handbook devotes complete attention to brick, clay, refractories, silicas, glasses, stone, concrete, and expanded minerals. Covered are such organics as tars, pitches, asphalts, waxes, paints, varnishes, lacquers, elastomers, plastics of all types.

### Fatigue Durability of Carburized Steel

*Available from Technical and Engineering Book Information Service, ASM, 7301 Euclid Ave., Cleveland 3, 6¼x9¼, 123 pp. $4.*

This discussion of fatigue durability is actually a series of lectures given before the ASM by members of the General Motors research staff. Load stress, residual stress, physical and metallurgical properties, and surface condition are all factors in determining fatigue durability in carburized

(Continued on page 151)

*"I dunno, Ed, I think I'd just as soon spend my vacation at Cape Cod."*

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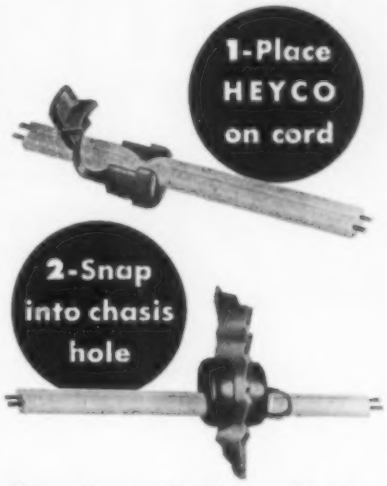


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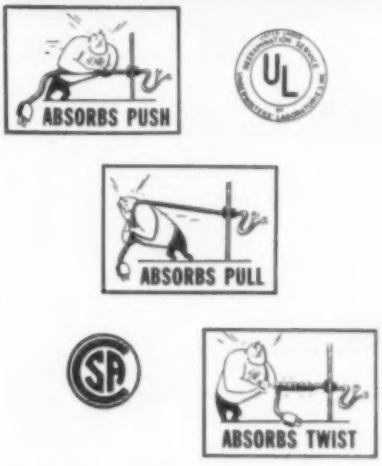


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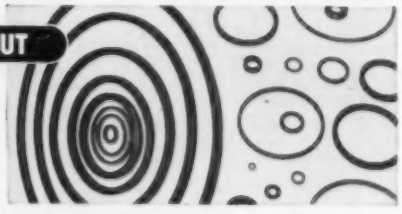
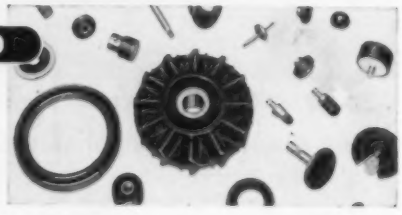


**BONDED**



GORSIL compounds are now available for adaptation to your next part problem that involves temperature.

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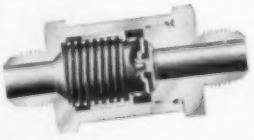
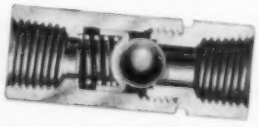
Save weight and space with Mini-Valves. They have same rated flow as regular size, but are only ¼ the size and weight. Good pressure drop characteristics. Temp. range -65° to plus 400°F. Operating pressure to 5000 psi. One-piece stainless steel body, in tube sizes 4 to 16 (¼" to 1" O.D.) Meets or exceeds requirements of MS MIL-V-25675. Port threading MS33514 flareless.



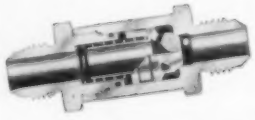
### FREE-FLOW CHECKS

Extremely low pressure drop, with wide open flow. Molded elastomer seal and spherical seat prevent leakage at any pressure. Sizes ⅛" to 2" in brass and aluminum alloy up to 3000 psi, and stainless steel to 4000 psi. Opens at 2 psi. Temp. range -65° to 200°F. Pipe, internal straight thread and flared tube connections standard; MS33514 flareless available.

### BALL CHECKS



Ruggedly constructed for intermittent non-shock hydraulic service up to 500 psi at temperatures -65° to 350°F. Sizes ⅛" to ¾". Brass, aluminum alloy, stainless steel. Pipe and flared tube connections.



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Built for continuous service in high velocity systems at pressures up to 5000 psi in steel and stainless steel, and 3000 psi in aluminum alloy. Low pressure drop. Metal-to-metal seal. Operating temperatures -65° to 250°F. Sizes ⅛" to 2", with pipe, internal straight thread and flared tube connections. MS33514 flareless available.

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steel parts. After establishing the necessity for a better understanding of the interrelation between these factors, the authors discuss results of their own research that would be of use to engineers who specify, design, produce, or use components of carburized steel.

### Structural Sandwich Construction

*ASTM Special Technical Publication No. 201, Published by ASTM, 1916 Race St., Philadelphia 3.* 6x9, 103 pp. $2.75.

The increased popularity of structural sandwich construction is largely a result of the recognized advantages of such characteristics as high strength-weight ratio and good stiffness factor, as well as growing industry confidence in the integrity of sandwich structures. The different segments of industry interested in sandwich construction have spent considerable energy and resources in R&D to improve performance and expand application. These efforts are reflected in this volume, which includes papers on high-temperature testing, selection of materials, nondestructive testing, bond-strength evaluation—as well as contributions in specific fields such as aircraft and architecture.

### Pipe Flanges and Flanged Fittings

*Published by ASME, 29 W. 39th St., New York 18.* 8½x11; 76 pp. $3.

This standard pertains primarily to cast and forged-steel flanges and flanged fittings. Included are: pressure ratings, sizes and methods of designating openings, marking, minimum requirements for materials, dimensions, tolerances, tests.

### Bibliography on Adhesive Bonding of Metals

*Compiled by Engineering Societies Library, 29 W. 39th St., New York 18. ESL Bibliography No. 12.* 8½x11, 23 pp. $2.

This is a selected list of over 150 annotated references to books and magazine articles published from 1947

(Continued on page 153)


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**can probably save you money . . .**

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**Greater Design Flexibility**
No need for access to both sides.



**High Clinching Action**
Exerts as high as 600 pounds squeeze between parts.



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Designer wants holes tight, production wants holes larger. "POP" Rivets make both happy.

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Strong, high grip "POP" Rivets need only enough back-up space to provide room for set head.

When buying fasteners, do you figure the *installed costs?* A fastener considered alone may cost very little but be very expensive by the time it's installed and becomes part of a finished product.

"POP" Rivets afford greater flexibility in product design. Often operations can be eliminated, assembly costs reduced, and speed of fastening increased.

Many users find high strength "POP" Rivets the most efficient and economical fastener for their product. Investigate its use in your application. Perhaps you too can enjoy the many advantages "POP" Rivets have to offer. Write us today.

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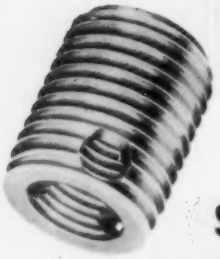

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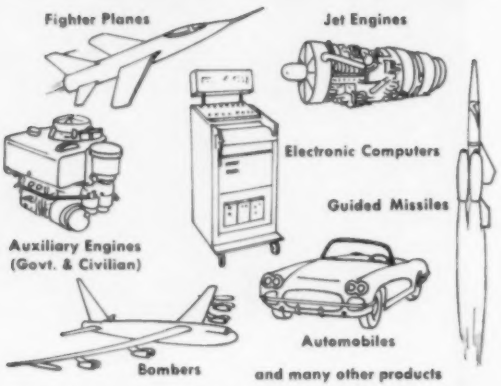


Tap-Lok Inserts provide heavy-duty steel threads for threaded fasteners in light metals, plastics and many other materials. They excel in saving time and cost in assembly, among all types of bushings designed for this purpose.

Tap-Lok Inserts are **SELF-TAPPING** and friction-locking in a single step. They increase thread strength 50% or more. They require no separate tapping operation, special hole preparation or secondary staking.

Tap-Lok Inserts are made in two types—the Regular Series, with a 2B internal thread for general applications in aluminum, magnesium and zinc die castings and sand castings; and the "H" Series, with 2B or 3B internal thread for use in wrought and high strength aluminum and magnesium castings, as in aircraft applications.

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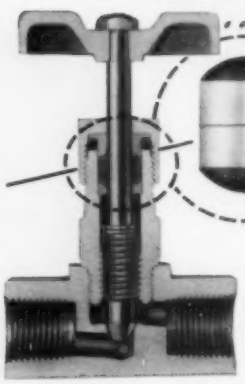
**The Marsh Stainless Steel Needle Valve could have gone right on being the finest in its field...yet we have improved it**



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Now "Teflon" is used in this packing system—the miracle material of almost incredible *toughness, resilience* and *non-adhesive* properties...properties that are not impaired by the most powerful of solvents, acids, or alkalies even at temperatures *up to 500° F.*

Net result: The guaranteed application-range (up to 10,000 psi) is now effective at any temperature up to 500° F. (In other makes, permissible temperature decreases as pressure increases.)

Marsh Marpak Teflon Packing System is standard in Marsh 416 Stainless Steel Needle Throttling Valves. Ask for facts.

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**stainless steel throughout**

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## Standards—Key to Progress and Profits

*Proceedings of the Eighth National ASA Conference. Available from American Standards Assn., 70 E. 45th St., New York 17. 8½x11; 160 pp. $4.*

Forty-four authorities from government, science and industry interpret the role that standards play in our economy. How standards have been applied to railroads, electronics, oil, insurance, construction, technical publishing, motion pictures, airlines, steel and metalworking is described.

## High-speed Photography

*Published by Society of Motion Picture and Television Engineers, 55 W. 42nd St., New York 36. 6x9, 200 pp. $3.50.*

Articles are included on photography and equipment for guided-missile research, light sources, electronic timing devices, special films, and methods for analysis for high-speed data. A color system for high-speed photography is illustrated in color. The volume ends with an 8-pp cumulative index of the contents of all six books in the series.

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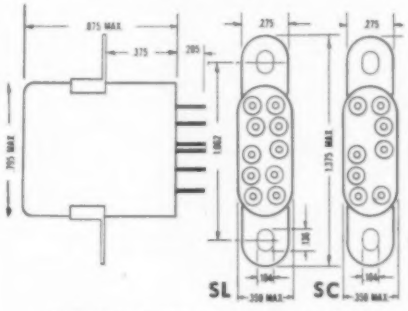
*SHOCK: 100g. VIBRATION: 30g 55 TO 2000cps. NO CONTACT OPENINGS.*

SC NON-LATCHING TYPE—This micro-miniature relay sets new standards—in design, in performance, in reliability. Yet the SC conforms to standard dimensions and circuitry and may be used to replace ordinary crystal-case relays. A permanent magnet in the structure provides *at least twice the contact pressure found in relays of comparable size.*

SL LATCHING TYPE—Unique magnetic latch assures exceptional contact pressure. A 1 watt, 3 ms. pulse to either coil transfers contacts. Transfer time is only 0.5 ms. Has the same exceptional shock and vibration characteristics as the SC.




**SC and SL Series Engineering Data**

**Operate Time:** 3 MS. max. with 550 ohm coil @ 24 V. DC. (SL: 630 ohm coil at 24 V. DC).
**Transfer Time:** 0.5 MS max.
**Terminals:** (1) Plug-in for microminiature receptacle of printed circuit board. (2) Hook end solder for one #20 AWG wire.
**Enclosure:** Hermetically sealed.
**CONTACTS: Arrangement:** 2 Form C.
**Material:** Gold flashed palladium.
**Load:** 2 amps @ 28 V. DC, resistive; 1 amp @ 115.V. AC, resistive.
**Pressure:** SC—13 grams min.; SL—16 grams min.
**COIL: Power:** Approx. 1.0 watt at Nominal Voltage.
**Resistance:** SL—40 to 1400 ohms; SC—35 to 1250 ohms.
**Duty:** Continuous.
**MOUNTINGS:** Bracket, stud and plug-in.

**GENERAL: Insulation Resistance:** 10,000 megohms, min.
**Breakdown Voltage:** 1,000 V. RMS.
**Shock:** 100g.
**Vibration:** 30g 55 to 2000 cps.; 0.195" max. excursions from 10-55 cps.
**Temperature Range:** -65°C. to +125° C.
**Weight:** 17.5 grams (5/8 oz.).

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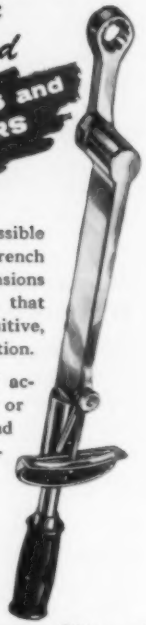

It is mechanically impossible to use any Torque Wrench with adapters or extensions (with accuracy) unless that Torque Wrench has a positive, built-in, fixed load position.

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Apr. 28, '58, p. 80. Second of three articles gives data for selecting the skin material. Circle No. E 22

**Fan Selection**
Apr. 28, '58, p. 92. Three fan laws; charts, tables and sample problems. Circle No. E 21

**Silicone Rubber Parts**
Tips on curing methods, shape of parts and material selection for best service. Apr. 14, '58, p. 69. Circle No. E 20

**Pressure Drops in Air Valves**
Technique estimates pressure losses in a pneumatic system, component by component. Charts give K-factors for actual valves and fittings. Apr. 14, '58, p. 74. Circle No. E 19

**Plastics for Abrasion Resistance**
Table lists specific properties of elastomers and rigid plastics that resist abrasion best. Mar. 31, '58, p. 105. Circle No. E. 18

**Instrument Bearings for 300 F and Up**
What happens to ball bearings operated above 300 F; special materials and lubricants that give better performance. Feb. 3, '58, p. 72. Circle No. E 17

**Textured Steel**
Types available; when, where and how to use it; two new processes. Mar. 17, '58, p. 73. Circle No. E 15

**Which Adhesives for What**
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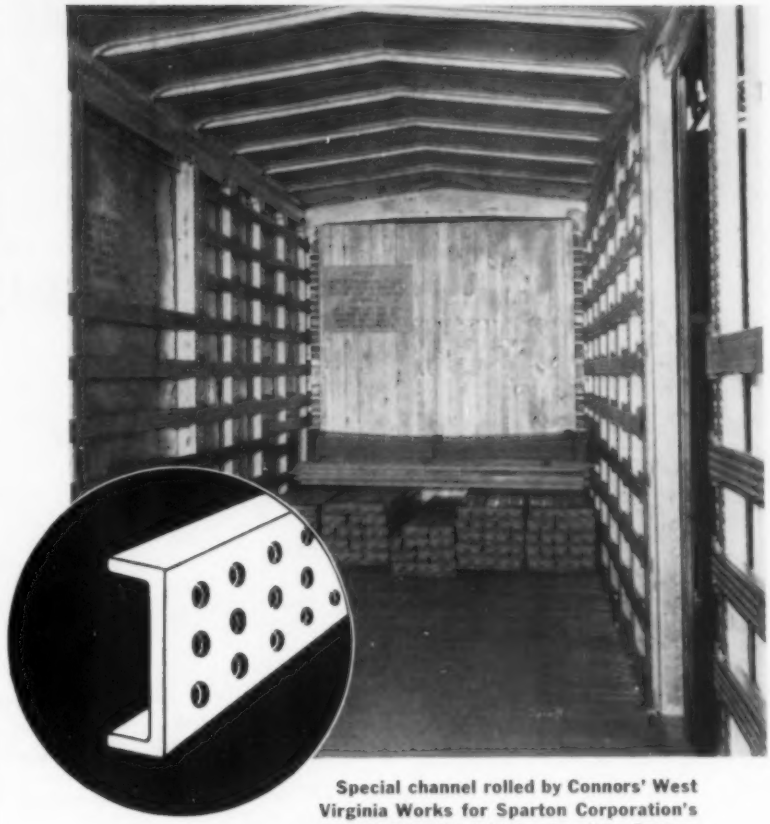

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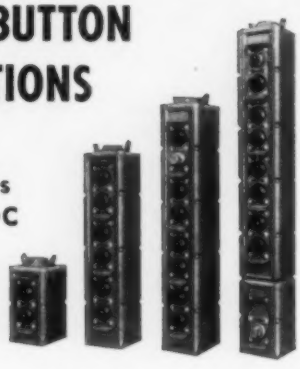

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**Which Way to Make a Cam**
A recognized authority shares his experience by means of a tabulation covering characteristics of 31 methods. Mar. 3, '58, p. 67. Circle No. E 10

**Which Cantilever Beam is Best**
Analysis discloses advantages of tapered sections; equations for four variable-section types compared with straight cantilever. Feb. 17, '58, p. 83. Circle No. E 7

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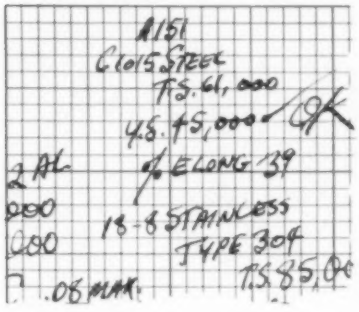
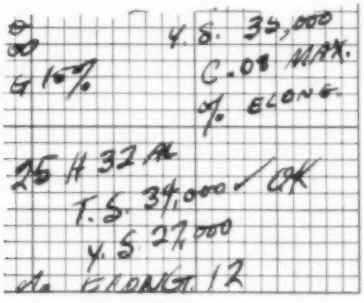
**How strength can be designed into component parts**

Only the stamping method of production offers such an unrestricted latitude of material selection. With stampings, strength can be designed right into a product or component part. It can be specified into the basic material and improved during the stamping process . . . it can be predicted, controlled and maintained. Strength in stampings can, in fact, be higher in proportion to weight than is possible in any other metalworking process.




All parts, pieces or units are designed around their predetermined end use. The end use pretty much dictates the material to be used in making the component. Only in stampings are the metal, finish and inherent characteristics of the part completely controlled and established beforehand by the design demands. With stampings, there is no need to sacrifice strength to gain other desirable properties. And in stampings, strength is achieved and not just approximated.




Durability is another quality inherent in every stamping. Because stampings are not fragile, they will not break or crack even when thrown out of line or dented by careless handling.

The resilience which characterizes stampings adds to their versatility in production, shipping, finishing and to the manner of their final assembly with other stampings, other component parts, to form a finished product.

# Stampings Keep Clutches Rigid

**COMMERCIAL close-tolerance stamped housings—ten sizes up to 40 inches in diameter—maintain dimensional accuracy in clutch and brake construction**

Because the side housings of the Fawick Airflex Type E clutches are stamped to close tolerances, no costly machining is required before assembling.

This unique clutch puts all the load on torque bars which rest on the stamped housings. The clutch design takes full advantage of the inherent strength of the positioned steel.

The Fawick clutch assemblies are used in a wide range of sizes for clutch and brake applications in heavy-duty original equipment. COMMERCIAL has been supplying the stamped housings for the assemblies since 1944 when they first designed and built the original dies.

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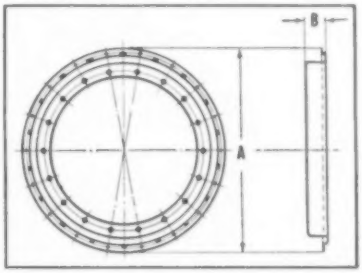
Gang piercing provides the required dimensional and location accuracy of holes and slots without the cost of multiple drilling. Slotted openings with integral tabs are formed without metal fracture. The sharp bottom radii and straight sidewalls require a deep draw. Yet, close tolerances must also be maintained on these dimensions.




| | | | | | |
|---|---|---|---|---|---|
| A | 11⅞ | 13⅞ | 15⅞ | 18⅞ | 21⅜ |
| B | 2⅝ | 2⅝ | 2⅝ | 2⅝ | 2⅝ |
| A | 23⅞ | 26⅞ | 29⅞ | 33⅞ | 39⅞ |
| B | 2⅝ | 2⅝ | 3 1/32 | 3 1/32 | 3 29/32 |

Typical tolerances in the Fawick stamped housings are +.005" − .000", +.005" −.005", +.000" −.010". Special notes on shop drawings call for all holes equally spaced, within tolerances of plus or minus .005" while parallel surfaces are maintained. COMMERCIAL'S ability to meet such stiff stamping requirements reflects its skill and experience in handling unusual metal forming problems.

Fawick's non-mechanical drum-type clutch requires the accuracy of COMMERCIAL stamped housings when continuous pressure is applied.

These clutches in use on power shovels, locomotive cranes and other heavy-duty equipment, keep the load from slipping through friction. The housings stamped by COMMERCIAL withstand the load and the heat generated by the friction involved, yet maintain the alignment and accurate dimensions to which they are stamped.

If you have a design problem involving component parts, we may be able to suggest a practical and economical solution based on our 30 years experience in forming metals. Send details of your problem to Commercial Shearing & Stamping Company, Dept. G-18 Youngstown 1, Ohio.

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*shearing and stamping*

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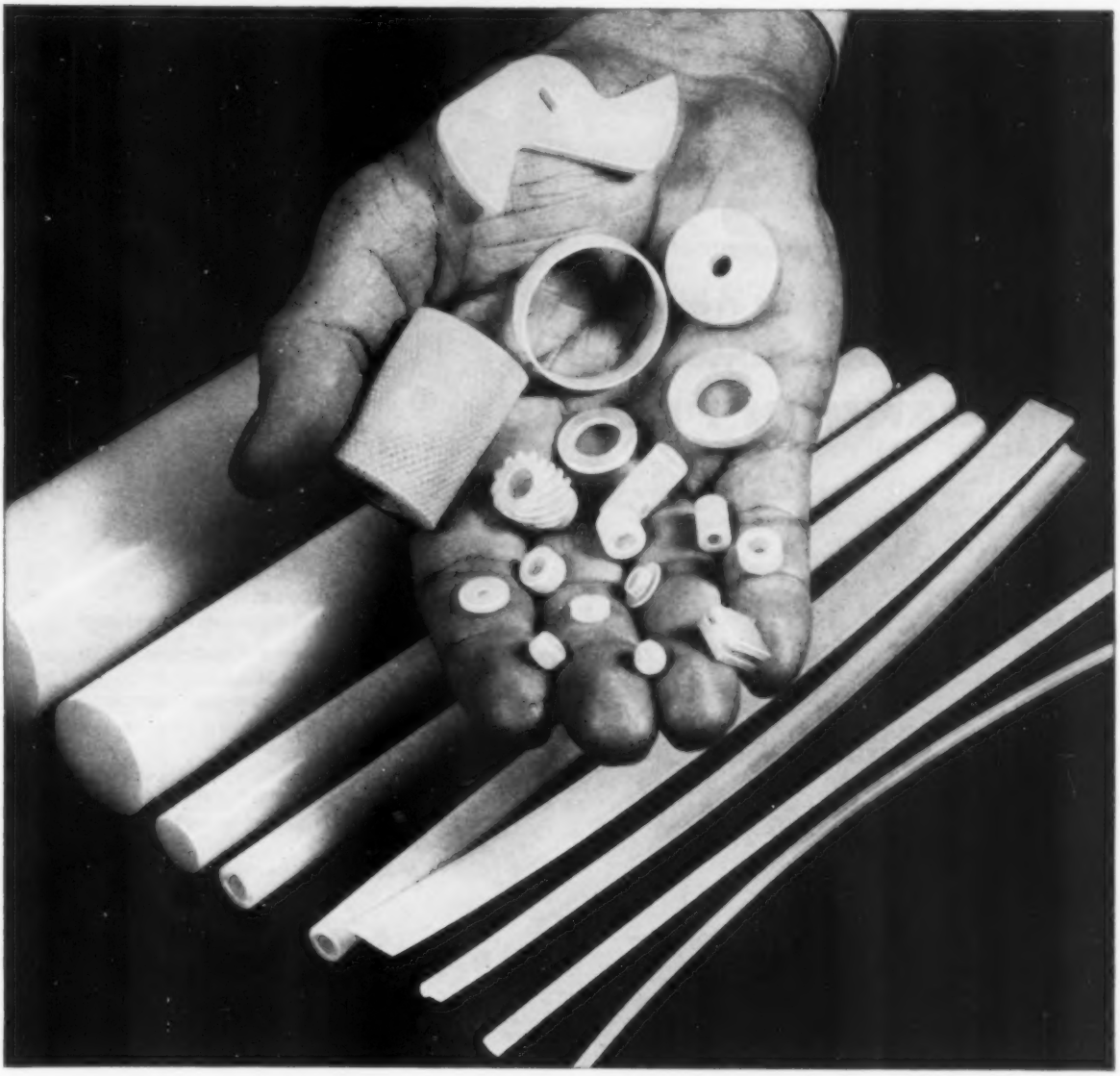

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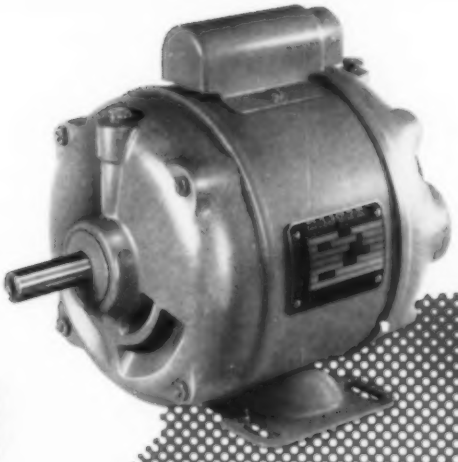

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So for any drive requirement—simple or complex—a glance at the data below will show you that Master is your best bet. Let us tell you more.

**Motor Ratings** ..... $\frac{1}{8}$ to 400 H.P. All phases, voltages, and frequencies.

**Motor Types** ..... Squirrel cage, slip ring, synchronous, repulsion-start induction, capacitor, direct current.

**Construction** ..... Open, enclosed, fan-cooled, explosion-proof, special purpose.

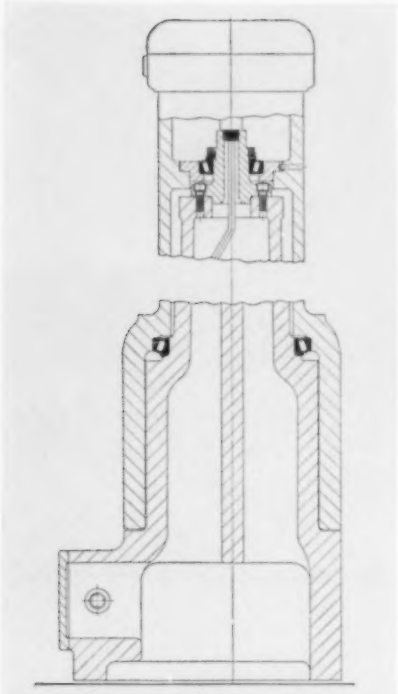
**Speeds** ..... Single-speed, multi-speed, and variable speed.

**Installation** ..... Horizontal or vertical, with or without flanges and other features.

**Power Drive Features** ..... Electric brakes (2 types)—5 types of gear reduction up to 432 to 1 ratio. Mechanical and electronic variable speed units—fluid drives—every type of mounting.

**THE MASTER ELECTRIC COMPANY** • Dayton 1, Ohio

DIVISION OF RELIANCE ELECTRIC AND ENGINEERING CO.



How **THE AMERICAN TOOL WORKS CO.** mounts column of 32-speed Hole Wizard Radial on 2 Timken bearings to increase rigidity 50%. Spindle and transmission use 11 more Timken bearings.

# This radial drill has 50% more rigidity with column mounted on Timken® bearings

TO resist stresses and cut arm deflection in half, the column unit of this 32-speed Hole Wizard Radial is mounted on two Timken® tapered roller bearings. With a large, preloaded Timken bearing at top and bottom, The American Tool Works Company gives the column and sleeve the rigidity of a single piece. This results in greater accuracy and longer cutting tool life, permits higher speeds and coarser feeds.

**HOW COLUMN IS HELD RIGID.** Timken bearings keep the column unit in positive alignment. Their tapered design lets them take both thrust and radial loads in any combination. And full line contact between rollers and races gives Timken bearings load-carrying capacity to spare.

**HEAVY SHOCKS ABSORBED.** Rollers and races of Timken bearings are case-carburized to give them hard, wear-resistant surfaces over tough, shock-resistant cores. They reduce maintenance.

**FRICTION VIRTUALLY ELIMINATED.** Timken bearings run smoother, last longer, because they're geometrically designed for true rolling motion—and precision-made to live up to their design. We even make our own electric furnace, fine alloy steel—the only American bearing maker who does.

So whether you buy or build machines, it pays to specify bearings trademarked "TIMKEN". The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

*This symbol on a product means its bearings are the best.*

**TIMKEN**

TRADE-MARK REG. U. S. PAT. OFF.

*TAPERED ROLLER BEARINGS ROLL THE LOAD*